OBJECT LESSONS IN NATURAL HISTORY

BY E. SNELGROVE, B.A.

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OBJECT LESSONS

IN

NATURAL HISTORY.

WITH AN APPENDIX ON

THE CORRELATION OF STUDIES WITH OBJECT LESSONS.

BY

EDWARD SNELGROVE, B.A.,

Head Master of Heeley Bank Board School, Sheffield; Author of "Object Lessons from Forest, Field, Wayside and Garden."

7720

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PREFACE.

THE forty-six Lessons herein set forth are offered as a complete course in Elementary Science for the three Junior Standards of Elementary Schools, so far as Natural History is concerned. With the exception of eight lessons, which have been added to give completeness, and to suggest future excursions further afield, all can be taught as true *Object* Lessons.

The animal kingdom does not supply materials for this purpose so readily or lavishly as does the vegetable kingdom, and although Botany is, in this respect, an ideal subject for developing the observing faculties of the young, it cannot be expected that Elementary Science should be confined to lessons in one department. These lessons are therefore offered as additions to "Object Lessons in Botany," and it is intended to follow them up by another course dealing with common things.

It is claimed on behalf of this arrangement that there is a very decided advantage in placing together related subjects, so that the threads of connection are clearly seen and firmly grasped; whereas, an intermixture of subjects (unless they have a natural correlation duly observed), is likely to produce

confusion, and to lead to much unproductive labour on the part of both teacher and pupil. Some remarks on the co-ordination of school studies are made in an Appendix.

It may be added that these lessons have all been tested by practical experience, and that the majority of them are at the present time being given, together with Botany Lessons, in the Heeley Bank Boys' School, Sheffield.

E. S.

January, 1897.

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OBJECT LESSONS

IN

Natural History.

LESSON I.

THE CAT.

A large picture of the animal and black-board drawings of parts. But a living specimen is better than a picture.

INTRODUCTION.—HABITS.

1. The subject of this lesson may be allowed to introduce itself. Every child knows something about a cat and will be ready with some information about it:—

(*a*) Cats are generally kept in our dwellings.
(*b*) They have coats of warm fur.
(*c*) When hungry they mew, and purr when pleased.
(*d*) When teased they scratch with their claws.
(*e*) They catch birds and mice to eat.
(*f*) Animals caught alive to be eaten are called prey. Mice are cats' prey.
(*g*) The cat walks on four feet.

FEET.

1. Let us now examine pussy's feet in order to see how they are made:—

(*a*) Each foot is small, and as soft as velvet.

(*b*) Underneath, there are small pads or cushions.
(*c*) Each fore foot has *six* pads, and each hind one *five*.

2. Of what use are these soft pads to the cat? It can walk without noise, as it wants to do when trying to catch a mouse or bird. Now we squeeze one of the fore paws, not too hard, and the claws are spread out. Look at each foot:—

(*a*) Each fore foot has *five* claws, and each hind foot only *four*.
(*b*) The claws can be drawn back into a sheath of skin, or spread out; they are hook-shaped and very sharp.

3. It should be noticed that:—

(*a*) The claws take the place of nails, though not exactly like nails, and grow at the ends of the toes.
(*b*) The inner toe of each fore foot, in the place of our thumb, is too short to be used in walking.
(*c*) The cat walks on her toes, the pads being underneath.

4. Now what advantage is it to the cat to be able to withdraw or spread out its claws as it pleases? What does it use its claws for? Scratching, or catching its prey. A cat never runs after a mouse or bird, but always steals up to it so as not to disturb it until it can spring upon it and seize it with its sharp claws. If then, the claws were always spread, what difference would it make to the walking? Its footsteps would be heard. And what effect would the walking have on the claws in that case? They would become blunt through rubbing on the ground. Thus we see how the claws are kept sharp and ready for use.

5. We cannot see how these claws are made to move, but inside the foot the bones are so fitted together and fastened by strong tendons worked by very strong muscles that they move with the greatest ease. The drawings in Fig. 1 show the tendons and bones, as they are, under the skin.

MOUTH.

1. Notice:—

(*a*) The cat's mouth is full of sharp teeth.

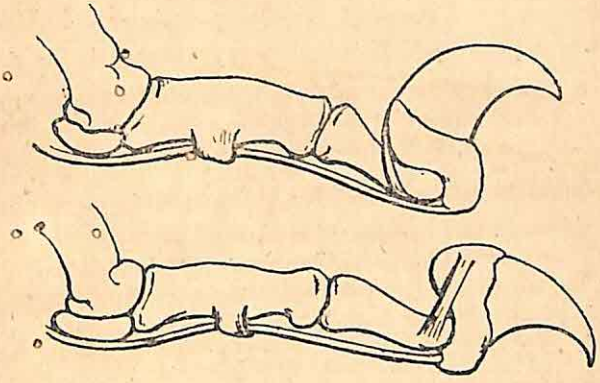
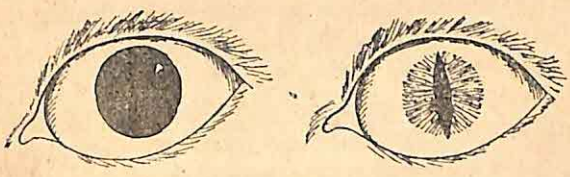


Fig. 1. Bones and Muscles of Cat's Toe. In the upper figure the claw is retracted by the action of the upper muscle; in the lower it is extended by the action of the lower muscle.



(*a*) (*b*)

Fig. 2. Eye of Cat. Showing pupil (*a*) in a dim light; (*b*) in a bright light.

(*b*) Four teeth (two on each side) are longer than the others. These may be called tusks, and are well suited for tearing flesh.
(*c*) The tongue is rough.

2. Most children will have felt the roughness of the cat's tongue, and the use of it will be seen when it is remembered the cat takes up its food with its tongue; if it has a bone it *licks* the meat off it. The cat also uses its tongue for cleaning its fur.

EYES—WHISKERS.

1. We have seen that the feet and teeth of the cat are well suited for catching and eating mice, but as mice generally come out of their holes at night, the cat must be able to find them in the dark, or at least, when there is not much light. Look at the cat's eyes in the daylight; compare with children's eyes:—

(*a*) Our eyes have a round black spot in the middle.
(*b*) The cat has a long narrow slit in place of this black spot.

2. It is through this black spot or slit that light enters the eye; all the rest is like a curtain to shut out the light. So the cat's eye only admits a very small quantity of light as we see it in the daytime; but look at it at night and you will see that the slit has grown larger until it is round like the spot in our eye and occupies almost the whole eye.

3. This then shows us that the cat's eye is made for seeing when there is not much light. When the light is bright it has to draw the curtains close. Even we ourselves draw the curtains closer when the light is bright, and the black spot becomes smaller.

4. But what are these strong hairs about the cat's nose and mouth? They are generally called whiskers, but better, *feelers*. Touch one and you will see the cat immediately jerk its head away as though the feeling were unpleasant. This shows us that the cat can feel with these whiskers, and in going about in the dark, it becomes aware of the nearness of anything before running its head against it.

OTHER FEATURES.

1. It should also be noticed :—

(*a*) A cat can easily get through small holes.

(*b*) This is because the body can be easily drawn out long and bent about in any direction.

(*c*) It can run up trees or poles, and jump to the ground from a good height.

SUMMARY.

1. The natural food of cats is mice and birds.

2. The bodies of cats are specially formed for catching and eating prey :—

(*a*) the feet for walking softly and preserving the claws,

(*b*) the claws for seizing,

(*c*) the teeth for tearing,

(*d*) the tongue for cleaning bones,

(*e*) the eyes and whiskers for guiding in a dim light,

(*f*) the whole body for gliding about and getting into narrow places.

USES.

1. We have several times already spoken of cats catching mice, and it is in doing this that they are of so much use to us. Some cats will also catch rats. If we had no cats we should be so overrun with mice that it is difficult to imagine how we could possibly be able to keep corn or any kind of provision. No doubt the children have heard the story of Dick Whittington and his cat. It might well be referred to here.

3. Let us hope that no child who has heard this lesson will ever be unkind to pussy, either by teasing her or by causing dogs to run after her. If pussy does so much for us, we owe her, at least, kindness in return.

LESSON II.

THE DOG.

A large picture of a dog, and black-board drawings; a dog's skull would also be useful.

INTRODUCTION.—USES, &c.

1. Our last lesson was about the Cat. Now there is another animal often kept in or about houses, and even more useful to us—the Dog. Dogs are of various sizes, and are kept for various purposes, *e.g.*:—

(*a*) The shepherd's dog—to drive sheep.
(*b*) The large mastiff—to guard.
(*c*) The greyhound—to catch rabbits.
(*d*) The small terrier—to catch rats.

2. Although dogs generally eat food like ours, they prefer some kind of flesh, being especially fond of bones.

GENERAL CHARACTERS.

1. Now look at the picture, and compare the dog with the cat:—

(*a*) Both are four-footed animals.
(*b*) The dog has a longer nose, and its head is therefore not so round as the cat's.
(*c*) It stands straighter up on its legs, and has not the crouching or gliding way of the cat.
(*d*) It wags its tail when pleased. The cat only lashes its when angry; and the motion of a cat's tail is quite different, like the motion of a serpent.
(*e*) The dog's coat is of hair; some have long, others short.
(*f*) The dog barks when pleased, when angry, to give warning, or at the word of command.

2. Now let us notice the head and face:—

(*a*) The ears are large. Some dogs have drooping ears, which can be raised when listening.

(*b*) The eyes have a round black spot in the middle, not a slit like the cat's. This spot or slit is called the *pupil* of the eye.

3. We thus see that the dog's eyes are not formed so well for seeing in a dim light as the cat's eyes are. But we noticed the large ears. It is through having such large ears that the dog can hear so quickly. And we know how readily the dog scents out a rat or a bone; you will have seen how a dog often runs along with its nose to the ground; observe the large nose, the great length from the eyes to the tip. It is through having such a large nose that the dog's sense of smell is so keen.

TEETH.

1. Most children will have seen a dog deal with a bone, and will be able to recall :—

(*a*) The dog's teeth are strong and pointed.

(*b*) Like the cat, it has four tusks.

(*c*) A dog's tongue is smooth and long; not rough, like the cat's.

2. A dog will let us look at its tusks. They overlap so far that when a dog has a firm grip of anything it is not easy to get it away unless its mouth is opened. These tusks are especially suited for tearing flesh, and with them a dog tears meat from bones. If you have a dog's skull you may also notice the back teeth; instead of being flat like ours, they are pointed. Notice, too, in eating, a dog's jaws do not move like ours, from side to side, but up and down, so that the action of these teeth is like the cutting of a pair of scissors. Cats' teeth also act in the same way.

3. So we may summarize :—

(*a*) The dog's teeth, like the cat's, are formed for tearing flesh.

(*b*) The eyes of the dog are not formed for seeing in a dim light.

(*c*) But the nose and ears of the dog are large, and so make its senses of smell and hearing very keen.

FEET.

1. The cat's feet we found to be very wonderfully formed, and

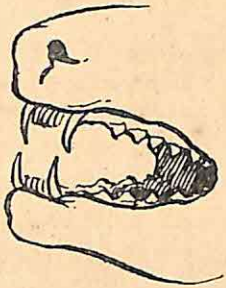


Fig. 3. Dog's Mouth to show form of teeth.

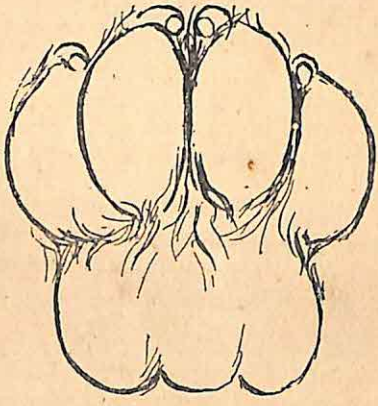


Fig. 4. Dog's Foot to show pads and blunt claws.

it will be interesting to compare the dog's feet with them. Looking at the picture, and recalling what has been seen, it will be noticed:—

(*a*) The dog has the same number of toes as the cat.
(*b*) Each toe ends in a claw.
(*c*) The claws are short and blunt.
(*d*) The claws cannot be drawn back, but touch the ground as the dog walks.
(*e*) The dog therefore cannot walk quite silently like the cat.

2. Those who have seen a dog seize a rat or a rabbit, will know that it does so with its mouth and not with its claws, which would be useless for such a purpose. Neither does the dog steal up to its prey, and spring upon it, but runs after it and relies upon its own speed. So most dogs can run fast, but especially greyhounds. The claws are not required for seizing, but they help in running by taking hold of the ground; thus they become blunt, but they serve their purpose equally well. So we see both the dog and the cat are fitted for what they have to do.

SUMMARY.

1. The dog is like the cat:—
   (*a*) It eats flesh, and has tearing and scissor-like teeth.
   (*b*) It has five toes on each fore foot, and four on each hind one.

2. The dog is unlike the cat:—
   (*a*) It has not the crouching or gliding habit of the cat.
   (*b*) It is unable to move its toes, and its claws are blunt.
   (*c*) Its eyes have not the narrow pupil, but a round one.
   (*d*) Its senses of hearing and smell are very keen.

3. Notice the contrasts:—
   (*a*) Both catch prey, the dog with its *mouth*, the cat with its *claws*.
   (*b*) The dog depends upon *speed* and force, the cat on *stealth* and its power to bend its body about.
   (*c*) Each is fitted for what it has to do, and it would be as strange to see a dog catch a sparrow as to see a cat hunt a fox.

INTELLIGENCE.

1. The dog is called the companion of man, and no animal can be so close a friend as a dog. Hundreds of stories are told of the wonderful understanding of dogs, and of their faithfulness to their masters.

2. There are hundreds of things too that dogs can be trained to do. Some drive sheep, some hunt foxes, some hares, some badgers, some guard our dwellings, some can track out people by scent, some, like the Newfoundland, rescue people from drowning, and others, like the St. Bernard, save people lost in the snow.

Note.—Wolves resemble dogs, but they are wild, and, like wild dogs, they always live and hunt in packs, being very cowardly when alone.
The fox also resembles the dog, but it has eyes like the cat.

LESSON III.

LIONS AND TIGERS.

Pictures of both these animals; drawings of a tiger's and lion's heads showing teeth; pictures showing these animals in their natural surroundings or catching their prey. Either or both of these animals should be previously seen in a menagerie or as stuffed specimens in a museum.

INTRODUCTION.—A COMPARISON.

1. This lesson will be about two of the fiercest and strongest animals living—the lion and the tiger. Perhaps they have been seen in a menagerie; but let us look at the pictures of them together. Observe:—

(*a*) The lion has a large mane, the tiger has none.
(*b*) The lion is brownish-yellow or *tawny*, the tiger striped.
(*c*) The lion's tail has a tuft at the end.

2. To get an idea of the size of these animals mark off these dimensions on the wall, and compare the weight with something known:—

	Length from nose to tip of tail.	Height.	Weight.
(*a*) Lion.	10 ft.	3 ft. 6 in.	500 lbs.
(*b*) Tiger.	10 ft.	3 ft.	460 lbs.

These are the sizes of full-grown animals, but not quite the largest that have been killed.

HOMES AND HAUNTS.

1. We have no fierce animals like these in our country; the lion is found in the deserts and forests of Africa and India; the tiger lives in the jungles of India where grass grows thick and

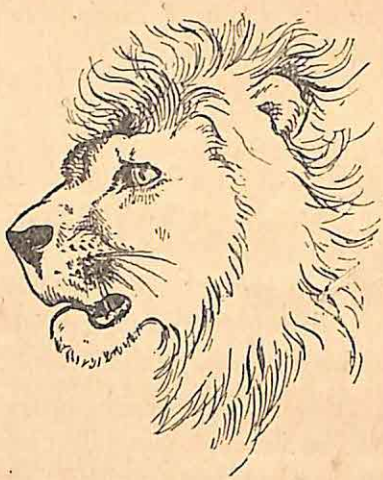


Fig. 5. Lion's Head.

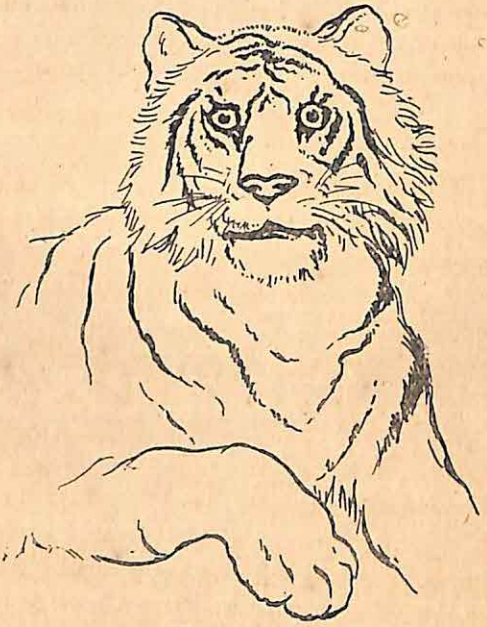


Fig. 6. Tiger.

tall. Both these are hot countries, where there are many kinds of animals on which both beasts can prey.

2. We have noticed the tiger's stripes. Travellers who have been to India tell us that when the tiger is amongst the grass of the jungle it looks just like the broad brownish-yellow blades of grass with the sun shining through them. Thus a tiger may be watching for its prey, and the prey whatever animal it may be, may think the tiger is nothing but the jungle grass, until the tiger suddenly springs upon it. Of what use then are the tiger's stripes? Would they be of the same use if the tiger took to living in green fields?

3. The lion has no stripes. But the lion lives in places where there are often rocks, or the ground is of a brownish colour; and even when it lives in woods it generally goes down towards evening and crouches on a river's bank, waiting till deer and other such animals come to drink. Then it is almost of the same colour as the mud or the reeds, and while an animal is drinking it suddenly springs upon it, and kills it.

The lion's colour, then, like the tiger's stripes, helps it to catch its prey with little trouble.

3. What then have we learnt? :—

(*a*) Both lion and tiger catch animals for prey.
(*b*) Both, *like the cat*, creep stealthily up to their prey.
(*c*) Both have colours suited to their homes to help them in catching their prey.
(*d*) Both live in hot countries, the lion in Africa and India; the tiger in India.

CHARACTERS IN DETAIL.

1. Let us now look at each animal more closely. Take the tiger first. Notice (as far as possible from the picture) :—

(*a*) The feet are like a cat's; the claws can be spread out or withdrawn, enabling the animal to walk softly, and to seize with them.
(*b*) The teeth are formed for eating flesh; the four tusks are readily seen in the open mouth.
(*c*) The tongue is rough like a *rasp*.

(*d*) The pupils of the eyes can become very large in the dim light, or very small in a bright light. (They do not, however, shrink to a slit but to a small spot.)

2. If we now turn to the lion we shall find the same kind of teeth, tongue, eyes, and claws, and we have already noticed the same way of attacking prey; in all these respects both animals are like the cat. They are, in fact, two different, but very large kinds of cats. They are like the dogs in eating flesh, but that is all. The father lion has a mane, but the mother is without. The Indian lions have not such large manes as the African.

3. We should expect such animals to be very strong. A tiger will sometimes strike down a cow, kill it, and even drag it to a hiding place. Either will attack a man, but only when hungry or when made angry by being hunted. Otherwise they are generally too lazy. It is sometimes said that the tiger is the fiercer animal of the two, but which is stronger is not certain.

USES.

1. Neither of these animals is of much use to us, but they are certainly a great danger to people and their flocks in the countries where they are found.

2. They furnish sport for sportsmen, who go out to shoot them, and their skins make fine rugs.

3. They are both very fine and beautiful to look at, but there is nothing noble in their ways, and the lion is as mean and sneaking in its habits as the tiger. The lion is called the king of beasts, but it is only kingly in its appearance.

SUMMARY.

1. The lion and tiger are flesh-eating animals.
2. They have teeth and claws like cats.
3. They strike down their prey as cats do.
4. Their colours are suited to the homes in which they live.

LESSON IV.

THE COW.

Picture of Cow; Drawings of upper and lower jaws to show teeth in front, of stomach and foot. Specimens of horn and hoof.

INTRODUCTION.—GENERAL APPEARANCE.

1. Everybody has seen a cow at some time. From cows we get milk and butter. They eat grass in the fields. Notice from the picture (aided by experience) :—

(*a*) The cow is a very large four-footed animal.
(*b*) The body is so large and heavy that the cow cannot run fast.
(*c*) Horns grow on the head.
(*d*) The body is covered with hair, and the long tail is bushy at the end.
(*e*) Each foot is made up of two hoofs.

FEET.

1. We will notice hoofs carefully because they differ so greatly from the clawed toes of the cat and dog. If we look closely, we shall see that each foot has also two small hoofs at the back, thus making four on each foot, although these small hoofs do not reach the ground, and are not used in walking.

2. Now what are these hoofs? They are coverings to the ends of the toes; that is to say, the cow walks on two toes, and these toes, as well as the two small useless ones, are preserved in a horny case which we call hoof. (Examine a specimen.)

Sometimes a cow's foot is spoken of as cloven-hoofed, but this is not an accurate way of describing it; it is best to speak of it as a hoofed two-toed foot, for the other two are so small that they form no useful part of the foot; they only show us that once cows had four toes.

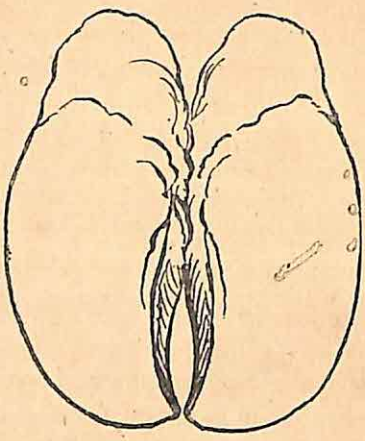


Fig. 7. Cow's Toes viewed from below.

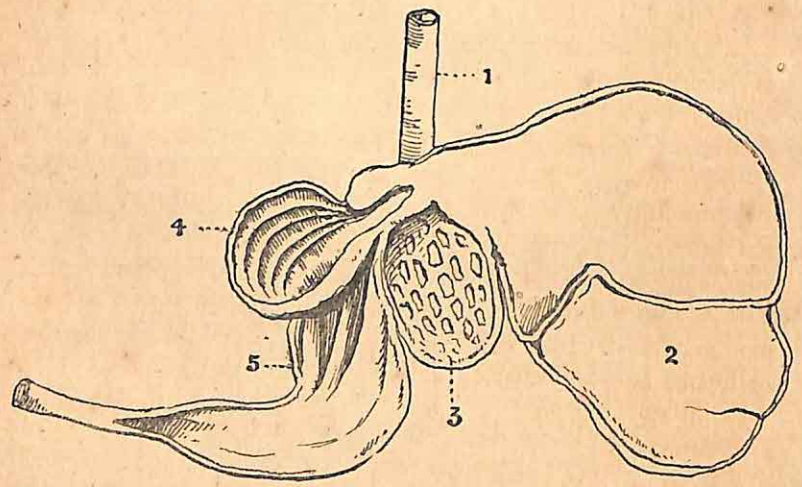


Fig. 8. Cow's Stomach. The numbers indicate the parts in the order in which the food passes through them. (In the Camel No. 3 is the water reservoir.)

HEAD.

1. We have noticed the large head and horns with which the cow can defend herself. Have you ever seen a cow eat? She seizes the grass with her tongue and tears it off. If we look in a cow's mouth we shall notice :—

(*a*) The cow has no upper teeth in front.
(*b*) There are no long tusks in the lower jaw.
(*c*) The back teeth are large and broad.

2. These are formed for eating grass, which is a cow's natural food.

RUMINATING.

1. Cows may often be seen lying down in the field, and although they have ceased biting off the grass, they continue for a long time to chew their "cud," as it is called. What really is taking place needs some explanation. One thing, however, can be seen, and that is the way in which the cow's lower jaw moves, viz., from side to side, and not up and down like the dog's and cat's.

2. The cow's stomach or bag into which the food passes as soon as it is swallowed, is not like the cat's or dog's, but consists of four compartments, or four stomachs (see Fig. 8). The food when bitten off is simply crushed by the grinding teeth and then swallowed, when it goes into the first stomach, or largest cavity (No. 2). When this is full the cow lies down, and some of this swallowed food passes into No. 3, from which it is thrown up into the mouth again in small quantities. It is there carefully and thoroughly chewed or masticated, that is, ground up and mixed with the juice of the mouth, and again swallowed into the third stomach (No. 4), from which it passes to No. 5, where it is digested or turned to use by passing into the animal's blood, and so going to build up its body. This long process of mastication is called *ruminating*.

SUMMARY.

1. The cow feeds on grass, and has a mouth, teeth, and

stomach specially formed for eating and digesting such food. She could not catch or live on mice or sparrows, or any kind of flesh.

2. The cow's foot is made up of two toes, each covered at the end with a hoof.

3. The cow has neither teeth nor feet for attacking other animals, only horns for self-defence, though cows will occasionally, and bulls oftener, attack with them.

USES.

1. The cow is a most useful animal. From her we get milk, and from the milk butter and cheese are made.

2. The young cow is called a calf, and the milk the cow gives is its food; but the calf is soon taken away and fed on only a part of its mother's milk, being left to eat grass, and the rest of the milk is used by us.

3. The cow's flesh is eaten as beef, and we shall see in another lesson, somewhat later, how her skin, horns, and hoofs are useful too.

4. In some countries (and to a small extent in England) oxen are used for ploughing or for drawing carts.

Note.—When we speak of the cow we mean the mother animal, the father is called a bull, and when we want to use a word to stand for either one or the other, we call it an *ox*; and if there are more than one, we say *oxen* or *kine*. They are often also called *cattle*.

LESSON V.

THE SHEEP.

Picture of the animal; black-board drawings of parts; specimens of wool, hoofs, and horns, if possible; a piece of woollen cloth.

GENERAL APPEARANCE.

1. The general appearance of a sheep is that of a bundle of wool on four thin short legs, having a small pointed head.

2. In summer, however, the sheep's body looks much smaller; then its wool has been shorn off, and the animal is about the size of a large dog.

HOME AND FOOD.

1. There are few places to which we can go without seeing flocks of sheep; in green pastures, on hillsides, on mountains, and on moors. But the sheep's natural home is the hills; on the dry uplands they thrive best. Young sheep are called lambs, the father sheep a ram, and the mother an ewe.

2. Sheep are never seen singly like cows, but are kept in flocks, and it is a peculiarity of theirs that they always keep together and follow a leader. Wherever the leader goes, the rest will follow. It will probably have been noticed :—

(*a*) Sheep are very timid, and are easily driven by a dog.
(*b*) They will rather go through a narrow opening than through a wide one.

3. Though sheep feed on grass, they readily eat turnips and corn.

WOOL.

1. What are sheep kept for? Their wool. This is cut off

every summer. They are first washed in a brook or stream of clear water, and then, when the wool is dry, it is cut off with shears.

2. This wool is of great use to us, for it is made into cloth. There are several towns in Yorkshire, besides others in different parts of the country, where thousands of people are engaged in large factories continually working up wool into cloth for clothing.

3. The stages in the making are:—

(*a*) Washing and cleaning the wool.
(*b*) Spinning it into yarn or threads.
(*c*) Weaving the yarn by means of a loom.

Take a piece of cloth, and pull out the threads so as to see how it is made up of crossing threads like basket work, or mat weaving. (*If suitable means are available, this might be the subject of a separate lesson, and the process of weaving illustrated.*)

4. The wool then, that was once the clothing of the sheep, is made to clothe us.

BODILY STRUCTURE.

1. Let us now look at the sheep more closely, and see what animal it most resembles. First, then, its head, of which a drawing should be made:—

(*a*) The head is without horns. (Many kinds have horns, generally curled.)
(*b*) The face is hairy, and the nose bare, like the cow's.
(*c*) In the mouth there are no upper front teeth, and no tusks at the bottom.
(*d*) In chewing, the jaw moves from side to side.

If sheep have been noticed lying in the field they will have been seen to be engaged in "chewing the cud." Therefore, as the sheep has grinding teeth, and no upper front ones, eats grass and chews the cud, we conclude:—

(*e*) The sheep is, like the cow, a ruminating animal.
(*f*) It will require a similar stomach to a cow's.

2. Such is the case. Now we will examine the feet:—

(*a*) Each foot consists of two hoofs.

(*b*) At the back of each foot there are also two very small hoofs, covering two nearly useless toes.

In this respect also then, we see the sheep is like the cow; it walks on two toes, each toe being protected by a hoof, which completely covers the end of it.

SUMMARY.

1. Sheep are kept for their wool, which is used for making cloth.
2. They are, like oxen, ruminating animals.
3. Each foot consists of two hoofed toes.

Note.—The goat is another ruminating animal with feet like the sheep. It is, however, clothed with long hair, and the male has long, nearly straight horns, and a beard.

LESSON VI.

THE COW'S FOOT.

THE FORE-LEG.

1. It will be well to try to understand more accurately the structure of the cow's and sheep's feet, for both are formed on the same plan. Now look at the drawing as shown in Fig. 9. There you see it bent as it is when the cow lies down, and we generally call this bending place the knee. This is only because it seems to bend like our knees; for, if you consider, you will see that it is the fore-leg, and corresponds to our arm, which can only bend in that way at the wrist.

2. Look further up the leg, and you will see what looks like, and actually does correspond to, our elbow (Fig. 9, 1).

3. The so-called knee then is really the wrist, and all the part below is what the cow has in place of a hand.

THE COW'S FOOT AND THE HUMAN HAND.

1. Bend your wrist so as to bring the back of the hand downwards, and rest upon it; then you represent the action of the cow when bending what are called her knees.

2. Now rest the tips of your third and fourth fingers (counting the thumb as the first) on the table; turn the others inwards; then the two finger tips on the table stand for the two toes on which the cow walks.

3. Imagine these two tips larger and each covered with a hoof, the thumb absent, the other fingers small, the bones that go through the palm of the hand to the wrist much longer, thicker, and grown together, and you have exactly the cow's lower leg and foot. The long bone is called the cannon bone.

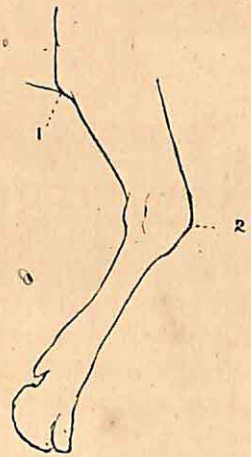
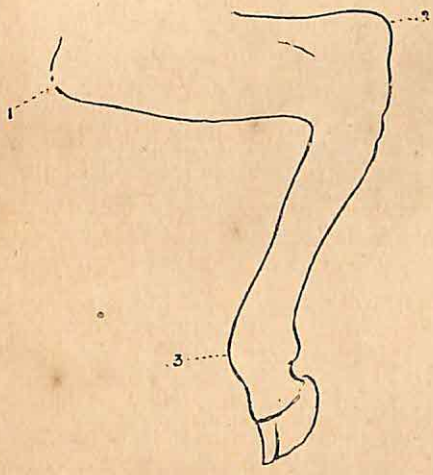


Fig. 9. Fore Leg of Cow. 1. elbow; 2. wrist, usually called the knee.



Hind Leg of Cow. 1. knee, usually called the stifle joint; 2. heel, usually called the hough or hock; 3. where the toes articulate with the cannon bone.

THE HIND LEG.

1. The hind foot is formed on the same plan; the backward point in the leg corresponds to our heel (Fig. 10, 2), and the joint like our knee is close up to the cow's flank and almost hidden. (See Fig. 10, 1.)

If it were not for the long cannon bone, the cow, when standing, would be no further raised above the ground than a pig is.

SUMMARY.

1. The cow's knees correspond to our wrists.
2. The two toes on which the cow walks correspond to our third and fourth fingers, and third and fourth toes.
3. The sheep's and goat's feet are like the cow's.

Note.—This lesson has been introduced to give some idea of homology, and if clearly and simply put, with illustration, is not difficult, but can of course, at the teacher's option, be omitted.

LESSON VII.

THE REINDEER.

Picture of the animal, specimen of antler of any deer, drawings as in figures below.

THE HOME OF THE REINDEER.

1. Assuming the children have before them a picture of a reindeer harnessed to a sledge, the lesson may be introduced by giving the animal's name.

2. The reindeer lives in a land far away from ours, in which snow covers the ground for the greater part of the year, and where neither horse nor cow could live for the intense cold. Some people who use this animal are called Lapps, and their country Lapland.

3. Looking at the picture it will be seen :—

(*a*) The reindeer is harnessed to a kind of carriage without wheels.
(*b*) This is made to glide over the snow. It is called a sledge.
(*c*) The reindeer therefore does the work of a horse, and has to run over the snow.

4. Not only is the country cold, but the snow is often deep, and even if a horse could live there it could not travel over the snow ; its feet would sink in too far.

HABITS AND USES.

1. Many reindeer are wild and roam about these cold countries ; when the ground is free from snow they feed on grass ; when there is no grass they eat the seaweed, and when everything is covered with snow they go up the mountains and feed on the lichens that grow on the rocks. Small lichens may be seen

often growing on our walls; they are generally like dry scaly bark. In its own country the reindeer has to push the snow away with its nose to find them. Nevertheless it manages to get fat on this food.

2. When the reindeer is tamed, it has to live on the same kind of food, for there is no other. But it is a most valuable servant to its master. The young reindeer is called a fawn, and it is treated as we treat calves; the mother is milked and the milk furnishes food for the Lapp family. The flesh also supplies food; the skin is used for clothing and making harness; so that altogether the reindeer is both horse and cow to its master.

3. The uses may thus be summarized:—

(*a*) Reindeer draw sledges over the snow and so do the work of horses.
(*b*) They supply the Lapps with milk and cheese, thus serving the purpose of cows.
(*c*) Their flesh is eaten.
(*d*) Their skins are used for clothing and making harness.

4. A Lapp reckons his wealth by the number of reindeer he has, a man sometimes possessing as many as a thousand.

STRUCTURE—ANTLERS.

1. Those who have seen English deer will recognize the likeness of the reindeer to them, especially in the horns or antlers as they are called. All deer have antlers, but in many kinds it is only on the males, or father deer, that these grow.

2. Let us compare these antlers with the horns of a cow or sheep. If you have specimens of both it will be seen:—

(*a*) The cow's horn is hollow and pointed.
(*b*) The deer's antlers are solid and branched.

But there is a further difference; a cow's horns when once formed stay on the cow's head always unless broken, or in some way knocked off, and if they are knocked off, great pain is caused to the animal, and they bleed. But the deer sheds its

Fig. 11. Antlers of Reindeer.

Fig. 12. Foot of Reindeer, showing two large and two small toes.

antlers every year, and new ones grow in their places; just like leaves falling from trees in the autumn and new ones growing in the spring.

We cannot get a cow's or sheep's horns without killing the animal, but deer's antlers or horns may be picked up when they have fallen off. Such horns are often used in England for making knife handles.

3. A reindeer is not quite so large as a small cow—about 4 ft. 6 in. high—but its antlers make it look large, for they are sometimes of great size, measuring as much as 4 ft. 9 in. in length. If these dimensions are marked on the wall an idea of the size will be gained.

OTHER CHARACTERS.

1. Looking at the picture we see :—

(*a*) The face is much like a cow's or sheep's.
(*b*) The feet are two-hoofed like the cow's.

2. The reindeer has the two-hoofed toes; the other two behind, which we noticed as being so small in the cow, are larger in the reindeer (see Fig. 12), and are of considerable use in travelling over the soft snow, for they spread out and make the foot larger. How will this help the animal? Think of the use of a small sledge or snow-shoes.

3. One other fact remains which cannot be known from the picture except by inference. We have seen that the reindeer has the same kind of legs and feet as the cow and sheep; it is also a grass-eating animal; we might therefore expect to find it a Ruminant, and such is the case.

SUMMARY.

1. We therefore find :—

(*a*) The reindeer has hoofed feet of two large and two small toes.
(*b*) It feeds on grass, seaweeds, and lichens, and is a Ruminant (or cud-chewer).
(*c*) It has solid branching horns called antlers, which are renewed every year.

2. Oxen, sheep, goats, and deer are all Ruminants, but they may be divided into two classes, according to the kind of horns they have.

(*a*) Hollow-horned Ruminants—*cow, sheep, goat.*
(*b*) Solid-horned Ruminants—*reindeer, deer.*

LESSON VIII.

THE CAMEL.

Picture of the camel; drawing of feet and cow's stomach (*Fig.* 8). *The living animal or stuffed specimen should have been previously seen.*

HOME OF THE CAMEL.

1. In our last lesson we learnt something about an animal that lives in the frozen wastes of the North; in this lesson we shall talk of an animal that is able to live on the burning sandy deserts of Arabia and Africa—the Camel.

2. In both these countries there are tracts of land where for miles nothing but sand is to be seen, and the sun shines all day long much hotter than ever it does in England. In these deserts, as they are called, there are, here and there, groups of small thorny bushes, or wells surrounded by palm trees and a little grass; but these are often several days journey apart.

3. Now these deserts must be crossed with loads of goods which have to be taken from people on one side to those who live on the other, and the camel is the only animal that can stand the sun, the sand, and the want of water. It has, in fact, been called the "Ship of the Desert," for the traveller could no more cross the desert without a camel than he could cross the seas without a ship.

4. Camels are not found wild except in the case of some that have escaped and become wild.

SIZE AND STRUCTURE.

1. Children may have seen a camel in a menagerie, otherwise,

we shall have to depend entirely on the picture. From this it may be observed :—

(*a*) The camel has four long legs.
(*b*) Its neck is bent so as to form with its shoulders a curve like the letter U.
(*c*) Its body has tufts of hair here and there, but not all over it.
(*d*) There is a great hump on its back.
(*e*) Each foot has *two* toes.
(*f*) Each toe has a nail on the upper side.

2. Two or three of these points need more attention. First of all there is the hump. When the camel is well fed this hump is large, when it has been long in the desert and had little food the hump is small and shrunken. It is on this hump that the load is placed, on it too, the traveller sits, and a very uncomfortable seat it is.

3. A great deal of the traveller's discomfort, however, is caused by the way in which the camel walks or runs. Have you ever noticed a horse walk or trot? It moves two legs at a time, but which two? The right fore leg with the left hind leg, and the left fore with the right hind one. But this is not the camel's way; it moves the two legs on one side at the same time, and this causes an awkward jolting motion. A light-legged camel (called a dromedary) can run about eight or ten miles an hour, but the ordinary camel only walks about three miles in that time.

4. Notice, too, the LARGE PADS on the camel's *wrists*, *elbows*, and *knees*. The animal kneels down to receive its load, and you will see that owing to the shape of its body, it can actually kneel on its *true knees*. (Refer to Fig. 10, 1.)

5. Look also at the FEET. We have noticed the two toes. Under these there is a large soft pad on each foot, so that the toes are joined together on the under side. When the camel walks the foot spreads out large, thus specially fitting it for walking in sand or soft soil.

6. The height of the camel to the top of the hump is about seven feet.

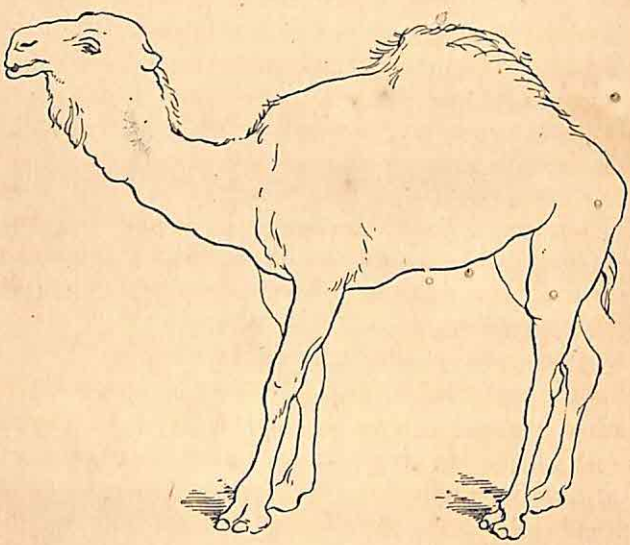


Fig. 13. One humped Camel.

FOOD.

1. The camel seems to be able to eat anything—grass, leaves, branches of thorny bushes, dates, and date seeds (which are generally ground into meal).

2. Although, however, it cannot go long without food, it is able to go without drinking for several days, sometimes as long as six days; and the reason is this: The camel is a ruminating animal, and has a stomach much like the cow's, only it has but three compartments instead of four. Now you may remember that the cow's second stomach had cavities or cells in the walls of it. In the camel's second stomach these cells are large and can be closed; when the camel drinks, it fills all these cells with water, and only lets out a little at a time, as it is required to pass up into the mouth with the food to be masticated (see Fig. 8).

3. If you have seen a camel open its mouth you will have noticed that it has two front upper teeth. Thus it differs from the other ruminants in two respects:—

(*a*) It has not hoofed toes.
(*b*) It has upper front teeth.

4. Notice also the nostrils. They can be closed; and when you know that sometimes hot winds blow in the desert, and great clouds of fine sand are carried about, you will see what a great service it must be to the camel to be able to close its nostrils, so as not to breathe the sand.

5. Thus you see the camel is especially fitted for desert life:—

(*a*) By the formation of its feet.
(*b*) By the food on which it can live.
(*c*) By its power of storing water.
(*d*) By its power of being able to defend itself against sand storms.

USES AND DISPOSITION.

1. The camel, then, is used for carrying, and doing all kinds of work that have to be done in a rough sandy and rocky district.

2. It also supplies its master with milk, and thus takes the place of the cow.

3. In Central Asia a camel is used, called the Bactrian Camel, which is a heavier animal, and has two humps on its back. It lives in colder regions, and often has to cross tracts of ice and snow, but it seems just as hardy in doing this as in crossing hot sandy wastes. Both kinds can travel twenty hours, and sometimes go forty hours without resting.

3. The camel is not a kind loving animal; on the contrary, it never seems to show any affection for its master; when it is receiving its load it moans and groans all the time, and it will bite anyone who comes within reach of its mouth. Nevertheless, its value to those who live in hot desert countries is beyond price.

SUMMARY.

1. The camel is the beast of burden for hot desert countries.
2. It is especially fitted for the work it does :—
   (*a*) By the form of its stomach, feet, and nose.
   (*b*) By its power of endurance.
3. The camel is a Ruminant, like the cow, sheep, and reindeer, but although it has two toes, it has neither hoofs nor horns.
4. The camel is as valuable to the Arab, as the reindeer is to the Lapp.

Note.—The llama of South America resembles the camel, and though smaller, it does similar work.

LESSON IX.

BUTTER AND CHEESE.

Specimens; a small quantity of new milk, previously set to show cream on it; any utensils that may be available; pictures of milk-supplying animals; a small quantity of condensed milk; hot water. Where possible, it would add to the usefulness of the lesson to produce butter by agitating a small quantity of cream in a bottle.

MILK.—WHENCE OBTAINED.

1. We have already referred to one reason why cows are kept in our country—to supply us with milk. We have also seen that other animals are used for the same purpose in other countries: the reindeer, camel, goat, and even the sheep. The goat is milked in England.

2. This milk is stored in a part of the animal's body called the udder or milk bag, from which it is drawn by the teats. But why is it stored there? It is only the mother animal that has the milk, and it is the food provided for her young; thus the cow provides for her calf, the reindeer for her fawn, the sheep for her lamb, the goat for her kid, and the camel for her calf. Usually, however, the mother animals are well fed so that they may give a large quantity of milk, and the young one is only allowed to have a small portion of it.

3. Now milk which is thus provided for the young animals is good food, especially for children. But we do not always use it just as milk; we have several ways of preserving it, otherwise it could not be kept long. To keep it a short time it may be boiled, and for various reasons it is best to boil it always before drinking it.

4. Condensed milk is now commonly used; what is it? Simply milk which has had the water driven out of it by heat, and a little sugar has been added to preserve it. How then can we make it like milk again? Add a little water to some, and notice the result.

BUTTER.

1. But there are two other ways of preserving milk much more common than this. (*Show butter.*) What is this? Now look at this milk which has been standing since morning. Something has risen to the top: cream. Observe that the cream *floats* on the top of the milk. Rub a little on a clean piece of white paper, what is noticed?

(*a*) Cream rises from the milk and floats on the top of it.
(*b*) Cream is therefore lighter than milk.
(*c*) Cream makes a greasy mark on paper.

2. Put a little butter or fat in milk or water:—

(*d*) Butter floats in milk.
(*e*) Butter also makes paper greasy.

Cream and butter are both forms of *fat* and are lighter than the milk, for they *float*.

3. Cream is the fat of the milk; people who keep cows take the cream from the milk, and when they have sufficient they put it into a churn, and dash it about at a steady rate for some time. This makes all the fat go together in little solid particles, and these particles are gradually worked together into one large lump, some milk that has been taken up with the cream remaining as a sour kind of milk. The fat thus obtained is butter. It only remains to wash it, salt it, make it up into suitable pieces, and it is ready for use.

4. We thus see:—

(*a*) Cream is the fat of milk.
(*b*) By churning, it is made into butter.

CHEESE.

1. Here is a piece of cheese; this also has been made from milk, or we may call it a kind of preserved milk. The process is as follows:—

(*a*) A large quantity of new milk is put into a vessel and kept slightly warm.

(*b*) A small quantity of *rennet* is added to it. (Rennet is an extract of calves' stomachs which have been salted and dried.)

(*c*) The rennet causes the milk to turn to curds and whey.

(*d*) The curd is pressed, and becomes cheese.

2. Cheese is a strong food, and contains not only the butter or fat of milk, but another substance called *casein*.

3. Many counties in England are noted for the kind of cheese made in them, but we also receive large quantities from other countries, as we do also of butter, especially from Ireland, Holland, Denmark, and America.

4. All the butter and cheese we use is made from cow's milk, but the Lapps have reindeer cheese, the Arabs camel cheese, and some countries sheep and goat cheese.

SUMMARY.

1. Milk is yielded by cows and other animals as food for their young.

2. People take the milk for their own food.

3. It is preserved in the forms of condensed milk and cheese.

4. Butter is obtained from the fat of the milk.

LESSON X.

HORNS AND HOOFS.

Specimens of hollow horns, hoofs, and antlers; bone, glue, melted glue.

HORN-AND-HOOF-BEARING ANIMALS.

1. In a previous lesson we noticed two kinds of horns :—

(*a*) Hollow horns.
(*b*) Solid horns or antlers.

Examine the latter, compare with a piece of bone, and it will be seen that they bear a close resemblance to dead bone.

2. Look now at the hollow horns; they seem to be made of a similar substance to that of the hoofs, and, when the animal was living, the hollow part was filled with a core of living matter, just as the hoofs were filled by the ends of the toes. Hence you will see why the horn could be injured.

3. Such horns as these are borne by many animals besides those we have mentioned, buffaloes, bison, and antelopes, all of which have even-toed hoofed feet, and belong to the class called Ruminants.

HORNS.

1. Now the purpose for which these horns grow is quite evident, viz., to give the animal a means of protecting itself from foes.

2. But just as people take the cow's milk for their own use, they also use the horns of these animals when dead. Notice the upper part of the horn; several inches of the tip are quite solid; this solid part is used for knife handles. Such may very probably have been seen. The thin hollow parts are used for

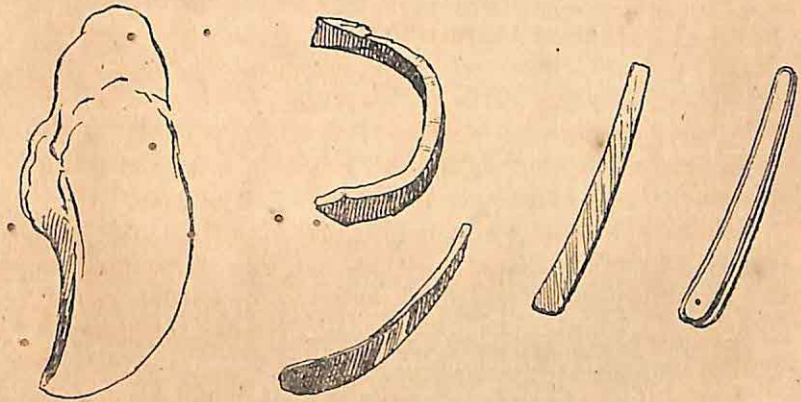


Fig. 14. Cow's Hoof used for making razor handles. Stages in the process of manufacture.

another purpose, as we shall see presently. Formerly drinking cups were made of them, as is sometimes done now, and drenching horns, shoe horns, &c.

HOOFS.

1. Hoofs, we have seen, are the covering of the toes. Examine a piece of hoof. Hold up a thin piece to the light; a little light passes through it (if it is not too thick). Cut it with a knife; compare with horn and bone :—

(*a*) Hoof is a kind of horny substance.
(*b*) It is tough, but not hard.
(*c*) It is therefore very suitable for protecting the feet from the rough and hard ground.
(*d*) It is slightly transparent.

2. Like the horns, the hoofs also are made use of when the owner no longer needs them. Cow's hoofs, and the hoofs of other large oxen-like animals, are cut up into strips; these strips are straightened, scraped, and polished, and so become scales for the handles of razors.

GLUE.

1. Here is a piece of glue. Notice :—

(*a*) It allows light to pass through it (partly transparent).
(*b*) It can be bent a little, but it is very stiff.
(*c*) It breaks with a crack or fracture.
(*d*) It can be melted, and it is then used for fastening pieces of wood together.
(*e*) When melted and left to cool it becomes solid again.
(*f*) It is much like horn or hoof.

2. Glue is made from horns and hoofs, or rather from those parts that cannot be used for other purposes, together with bits of hide. The processes in the making are :—

(*a*) Washing in lime water.
(*b*) Boiling, skimming, and straining.
(*c*) The liquid is then heated to drive off all the water in the form of steam.
(*d*) What is left is cooled in moulds, cut into slices, and dried upon nets. (Notice the marks of the net on the piece of glue.)

SUMMARY.

1. Horns and hoofs grow for the protection and defence of the animals that bear them.

2. Both are used for making knife or razor handles and other articles.

3. The thinner portions are used for making glue.

4. Solid horns or antlers are sawn up for knife handles, &c.

LESSON XI.

THE COW'S GIFTS TO MAN.

Specimens of horn and hoof or articles made from them; glue, pieces of leather; tallow candle.

RESUMÉ FROM FORMER LESSONS.

1. We have in former lessons talked of the uses of the cow, or, as we may call them, the cow's gifts to us. Let us recall these :—

(*a*) The cow gives milk, from which we get cream, or butter, and cheese.
(*b*) When killed, the cow's horns and hoofs are used for knife or razor handles and drinking cups.
(*c*) Glue is made from pieces of hoof and horn.
(*d*) The cow's flesh is eaten as beef.
(*e*) Besides all these uses the cow (or ox) is sometimes used to draw the plough.

LEATHER.

1. What are boots and shoes made of? Leather. Now let us think a little why leather is used and not cloth, for instance, as in the case of other parts of clothing :—

(*a*) Leather is thick.
(*b*) Leather is tough and does not tear.
(*c*) Leather does not let water pass through it.

Iron or wood would not let water pass through them; might they not then be used? Iron would be too heavy. Take a piece of leather and see how easily it bends. Neither wood nor iron can be bent in the same way. Because it so easily bends, we say leather is *pliable*, and something which is pliable must be more comfortable to wear than substances which are not. We

see therefore further reasons why leather is used for covering the feet:—

(*d*) Leather is light.
(*e*) Leather is pliable.

And we have already seen that it is *tough*, and does not admit the water (*i.e.*, it is waterproof).

2. What is leather made from? The skin of the cow or ox. When the cow has been killed, the skin is taken off, and is then called a *hide*. From hides leather is made.

3. Think now of a cow's hide and look at a piece of leather and you will see at least two changes that have taken place:—

(*a*) The hair has been taken off.
(*b*) The colour has changed to a dark brown.

4. In its condition as a hide it was fleshy and soft; without having something done to it, it would have turned *bad*. Certainly the hair is first removed, having first been soaked in water, and is used for mixing in plaster to make it hold together better. But it still remains to *cure* the hide.

5. The curing is done by laying the hides in a tan pit. One way of doing this is to put oak bark into the pit, and there is a substance in the oak bark which makes the hide shrink and become thicker and tougher. In this way it becomes leather.

6. Leather requires keeping soft and pliable; water causes it to harden and to crack. Oil or grease is used, and perhaps no grease is better for this purpose than one obtained by boiling the feet of the cow. (The oil thus obtained is called neat's foot oil. *Neat* is an old name for cattle.)

TALLOW.

1. What is this candle made of? Fat; tallow. Both answers are correct. Tallow is the fat obtained from the cow (or ox) when killed.

2. Notice there is something besides tallow—the wick, but it is the tallow that burns. Light the candle. Observe:—

(*a*) Heat melts the tallow.
(*b*) The wick is lighted, but the tallow is burnt up.

3. Other animals besides the cow give us tallow, *e.g.*, the sheep ; and others, too, yield leather.

SUMMARY.

1. In this lesson we have learnt that the cow gives us :—

(*a*) Leather which is made from the hide or skin.
(*b*) Hair which is used to mix with plaster.
(*c*) Oil which softens leather.
(*d*) Tallow for making candles.

LESSON XII.

THE HORSE.

Picture of horse; black-board drawing of the same and foot; horse's shoe and hair.

GENERAL APPEARANCE.

1. Of all the animals which live with us or serve us, none has a finer or nobler appearance than the horse. It has no antlers like the reindeer or horns like the ox, but the shape of its body and the action of its limbs give it a grace which is much admired.

2. Let us notice :—

(*a*) The horse's legs are long and nearly straight, with just enough thickness and curve to suit the length.

(*b*) It carries its head well up.

(*c*) Its neck is gracefully curved and adorned with a flowing mane of hair.

(*d*) Its chest is bold and broad, quite unlike that of the ox, which can hardly be said to have one.

(*e*) The body is not too large and heavy, like the cow's, nor awkward like the camel's.

(*f*) The tail, too, when allowed to grow is very handsome.

(*g*) The body is covered with short hair.

3. Altogether then, the horse, when compared with those animals which are used to do similar work, appears to us a much more beautiful animal.

USES.

1. It is not, however, on account of its beauty alone that the horse is so much valued, but because it is useful to us. What then are the uses to which it is put? In answering this question we shall be reminded :—

(*a*) That some horses have thinner legs and light compact bodies.
(*b*) That others have much heavier limbs and heavier bodies.
(*c*) That some are small and are called ponies.

2. Now let us note some of the uses to which the horse is put:—

(*a*) The lighter horses draw carriages and carry riders, both in hunting and travelling.
(*b*) The heavy-limbed horses draw heavy loads in carts or drays.
(*c*) They draw the plough and in various ways help to cultivate the land.
(*d*) They are used by soldiers for drawing cannon, or taking their riders into battle.
(*e*) Ponies do similar work but of a lighter kind.

3. Now it is owing to the shape of the horse's body and the form of its limbs that it is able to do all these kinds of work so well. So although the camel is prized for its great use the horse is prized both for its use and beauty.

4. Let us see how its form so well fits it for its work:—

(*a*) The fine long limbs and light body are suited to great speed. On the level horses can trot at rates varying from eight to twenty miles an hour. The higher speed cannot be kept up for long. Nor can a horse at any time go on for so long as the camel.
(*b*) The broad shoulders and chest enable the horse to move great loads. A good strong dray horse will draw over four tons on the level. (An ordinary load of coal is about a ton without the cart.)
(*c*) No other large animal is so well formed for leaping as the horse. In hunting, horses leap hedges and streams. The greatest leap on record is nearly 12 yards.

5. As the camel is suited to the desert and the reindeer to regions of ice and snow, the horse is suited to do work in a country like ours. It cannot stand great heat or great cold, but it can do work requiring great strength and great speed.

6. Much work that used to be done by horses is now done by steam and electricity, but still we have more work for horses than ever.

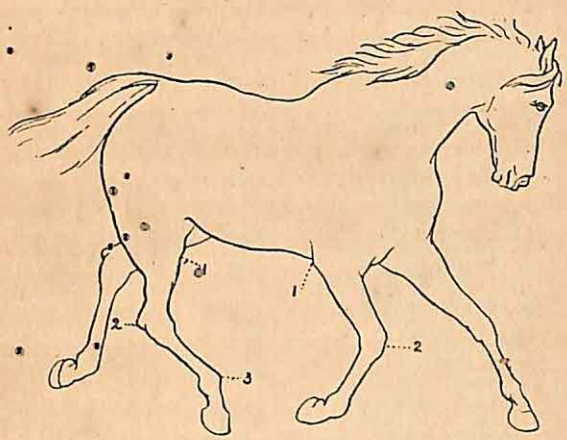


Fig. 15. Horse. Fore limb, 1. elbow; 2. wrist, called the knee. Hind limb, 1. knee, called the stifle joint; 2. heel, called the hock or hough; 3. fetlock or place where the one toe articulates with the cannon bone.

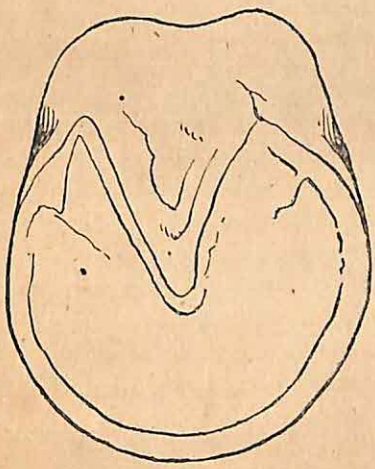


Fig. 15*a*. View of Horse's Hoof from below.

7. The mother horse is called a mare, and a young one a foal at first, afterwards when over a year old, a colt or filly.

STRUCTURE—FEET AND MOUTH.

1. So far we have taken no notice of the horse's feet; now we see :—

(*a*) Each foot is in one piece, and is made up of one solid hoof.
(*b*) On this hoof the horse wears an iron shoe.

The shoe, of course, is put on to protect the hoof from the hard roads which would soon wear it away down to the flesh which it covers. The nails are driven into the hoof, and the blacksmith has to be very careful not to prick the flesh when he fastens the shoe on.

2. Recall now how the cow's toes were shown to be in the place of our third and fourth fingers (and toes). Similarly the horse's foot consists of one toe (instead of two), which is in the place of our *third* or longest *finger* (or third toe, on the hind foot). Thus comparing the horse's foot with the human foot and hand (see Fig. 15*a*) :—

(*a*) The hoof is in place of the third finger (or toe) nail.
(*b*) The fetlock is in place of the upper end of the finger (or toe).
(*c*) The "knee" of the fore leg is the horse's wrist.
(*d*) The elbow is close to the shoulder.
(*e*) The hock (or hough) is made by a similar bone to our heel.
(*f*) The true knee is what is called the stifle joint.

3. We therefore see that the horse's legs are similar in build to the cow's and camel's, but while these animals both walk on two toes, the horse walks on one, which has grown specially large, and become suited to the purpose, and the long bone also between the wrist and fetlock is called the "cannon" bone. There is no trace of any other toe except on the cannon bone and underneath the skin.

4. The horse's teeth are not like the cow's :—

(*a*) The horse has front teeth both top and bottom with which it is able to bite.
(*b*) Like the cow it has no tusks.
(*c*) The back teeth are large grinders.

The food of the horse, therefore, as is well known, is such as requires biting and grinding, *e.g.*, grass and corn, but the horse *does not ruminate. All the Ruminants have two toes to each foot.*

INTELLIGENCE AND DISPOSITION.

1. The horse, unlike the camel, often shows great understanding, and many stories are told of the cleverness of horses. But everyone has seen how easily a horse gets to understand what is required of it, especially when treated kindly.

2. A horse's fondness, too, for its master is quite as remarkable, and many horses show their love for those who have to look after them, and for those who treat them kindly. It would be difficult to say, in some cases at least, which is the more faithful animal, the horse or the dog.

SUMMARY, &c.

1. The horse resembles the Ruminants in :—
   (*a*) Eating grass and having suitable teeth.
   (*b*) Having hoofed feet and long cannon bones.
2. The horse differs from the Ruminants in :—
   (*a*) Not Ruminating.
   (*b*) Having no horns.
   (*c*) Walking on *one* toe.
   (*d*) Having a full row of upper front teeth.
3. The different kinds of horses are :—
   (*a*) Hunters and carriage horses.
   (*b*) Cart horses.
   (*c*) Racers.
   (*d*) Ponies.

Note.—1. A horse is measured in height from the base of the fore foot in a vertical line to the *withers*, or top of the shoulder. A large powerful horse may be as much as 18 hands, but 16 or 17 is a more common height, while a Shetland pony is often no more than eight hands. A *hand* is the breadth of an average man's hand, when the thumb is pressed close to the side of the palm on a level with it. Its exact measurement is four inches.

2. Horses are found wild in Asia and in America. Many are found which are descended from tame horses that became wild years ago.

LESSON XIII.

THE ELEPHANT.

Picture or model of the elephant; drawing as in Fig. 16 below; piece of ivory. The living animal should have been previously seen.

GENERAL APPEARANCE.

1. We come now to the oddest, strangest-looking creature that ever was seen, the Elephant. No one who had never seen one would ever imagine such an animal. Seen walking slowly along, it appears like a great moving mass on four straight legs, with a tail at each end. Yet, curious as it is, it is one of the most interesting of all animals.

2. Though the elephant does not belong to our country, yet it is often seen here in menageries or circuses, and many stories are told of the clever things elephants are easily taught to do.

3. Let us now look at the picture and see what the animal is like:—

(*a*) The body is very large, and slopes off down towards the tail.
(*b*) The legs are very thick, straight, and long, almost like wooden props.
(*c*) The head is large, and has, where the nose should be, a long hanging trunk.
(*d*) Springing from behind the trunk are a pair of long horn-like things, called tusks.
(*e*) The elephant's skin is almost quite bare.

Tusks are usually found in the father elephants only.

STRUCTURE.—HEAD, TRUNK, TUSKS.

1. Before looking at the animal more closely, it would perhaps be well to get some idea of the size of a full-grown elephant.

Mark on the wall a line 11 ft. from the ground, and two uprights about 14 ft. apart; imagine the trunk at one end and the tail at the other. Many elephants are smaller, and a few larger than this; 12 ft. is the greatest height recorded, but many are only 8 or 9 ft.

2. We must now examine the build of this enormous creature, and will begin with the head; observe :—

(*a*) The ears are very large and flapping.
(*b*) The eyes are very small.
(*c*) The forehead is very high.
(*d*) The trunk is long enough to touch the ground.

3. Now what is this trunk? It takes the place of the nose, and is, in fact, a nose grown very long. At the end of it is a little point like a finger, with which the elephant can pick up small things. If the children have seen an elephant, they will have noticed that it breathes through its trunk; and there are two nostrils passing through it. But besides being a nose, and having a finger at the end, the trunk can be used for taking up water, which the elephant can blow out again in any direction it pleases.

4. But where is the elephant's mouth? When the animal raises its trunk the mouth is seen behind, a mouth of a peculiar shape, into which food and water are put by the trunk. The points to be noticed about it are :—

(*a*) There are no front teeth either at the top or bottom except the tusks.
(*b*) The tusks grow from the top. They are simply two front teeth* that have grown large.
(*c*) Of back or cheek teeth, the elephant has only one in each jaw on each side (*i.e.*, four) in use at any one time.
(*d*) The crown of each tooth is about 6 in. long and 2½ in. wide. (*Sketch on black-board.*)
(*e*) As one tooth wears away another comes up beyond it until the sixth.

* Incisors, not canines.

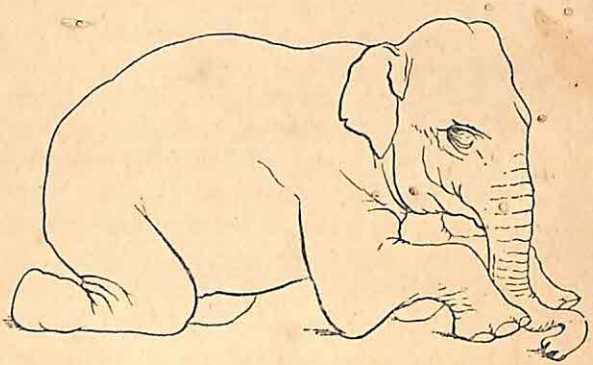


Fig. 16. Elephant kneeling. With the hind limbs it rests on its true knees; with the fore limbs on its elbows.

5. Three facts must be noticed in regard to the tusks :—

(*a*) What they are made of. Tusks are very hard and strong, and made of a beautiful substance called ivory (*see specimen*).

(*b*) Their length and weight. From 5 to 8 ft. is the ordinary length, and the weight of a good pair 40 pounds each.

(*c*) Their use. The elephant uses its tusks to fight with and to dig up trees.

Tusks have been brought from Africa of various lengths up to 20 ft., and a single one has been sold which reached the weight of 188 pounds. We can easily see then that it requires an enormous head to bear such weights as these, and that they must be most formidable weapons of defence or attack.

STRUCTURE.—LIMBS.

1. We have referred to the legs of the elephant, but we shall best see how they differ from a cow's or a horse's if we look at a drawing of an elephant kneeling, as shown in Fig. 16.

2. First, however, let us notice the feet :—

(*a*) The foot looks simply like the end of the leg.

(*b*) There are five nails on each fore foot, as though the elephant had five toes.

This is really the case. The animal has five toes on each fore and hind foot (though only four nails are seen on the latter), but these can only be properly seen in the skeleton.

3. Now from the kneeling figure we see :—

(*a*) The elephant kneels on its true knees and rests on its elbows.

(*b*) The upper part of the leg is long and the lower part short.

The elephant has no cannon bone, and the wrist is quite close to the fore foot and the ankle to the hind foot. A boy could easily kneel down in the elephant's way.

DISPOSITION AND USES.

1. Though the elephant is so large, it is easily tamed and taught to do various kinds of work. It is a willing servant, and becomes very fond of its master, and is often very mild and good tempered, but it never shows itself so well able to understand as

the horse or dog. It would never think of saving its master from drowning or from a foe unless told what to do.

2. Elephants are used to carry loads on their backs, draw carts or cannon, plough the land, stack up timber, or to hunt tigers. When drawing, the rope is passed through their mouths; when stacking or removing timber, they lift up the pieces with their tusks and trunks. The elephant is afraid of the tiger, but is taught to face it.

HOME.

1. Elephants are found wild in Africa and India. The African is a larger kind than the Indian, and lives in vast herds in the great forests of that country. There they are shot by hunters or trapped by the natives for their ivory.

2. Their food consists of grass and leaves and fruits of trees, which they sometimes pull down to get at the top branches.

3. In India elephants are generally caught by being driven into enclosures, from which they are taken and tamed and trained to work.

4. Elephants live to a great age, often more than a hundred years, and, it is thought, to as much as a century and a half. It is a strange thing that a dead elephant has never been found.

SUMMARY.

1. The elephant is like the horse and the ruminants in feeding on grass and not on flesh.

2. It differs from them in:—

(*a*) Having five toes on each foot.
(*b*) Walking on the whole foot and not on the toes.
(*c*) The build of its legs.

3. Two of the elephant's teeth grow as tusks and are made of ivory. Besides these, it has only large cheek teeth.

4. The most remarkable thing about the elephant is its trunk, which is to it a nose, a hand, and a water vessel.

5. The elephant is the largest of all animals that live on the land. (Jumbo was 11 ft. high, and weighed 6 tons.)

LESSON XIV.

THE RABBIT.

A live rabbit; a rabbit's skull with the teeth should be preserved for use; a joiner's chisel.

GENERAL CHARACTERS.

1. Perhaps no animal is so great a favourite with boys as the Rabbit. All rabbits, however, are not tame; many are wild and live in the fields; children will know :—

(*a*) Wild rabbits are usually grey, though sometimes black.
(*b*) Tame rabbits are of various colours.

2. Some reason for this difference of colour we will try to find out before we finish this lesson. Let us now examine as carefully as we can what kind of animal a rabbit is; it will readily be noticed :—

(*a*) The rabbit is covered with fur.
(*b*) It has long ears; some have very long drooping ones.
(*c*) The rabbit always seems to sit when not moving about.

3. Now why is this? Pick up the rabbit and notice :—

(*a*) The fore legs are very short.
(*b*) The hind legs are long, and the rabbit rests on the lower part.

So it seems; but what the rabbit does is to rest on a long hind foot; it is this great length of hind foot that makes the hind legs longer than the fore.

4. Let us see the rabbit move; how does it go? By jumps or leaps. It lifts up its fore feet from the ground and springs forward on its hind toes.

5. Examine now the feet :—

(*a*) There are *five* toes on each fore and *four* on each hind foot.

(*b*) Each toe has a strong claw, much like a cat's, but it cannot be drawn back.

(*c*) The rabbit, when wild, uses its claws for scratching holes in the ground. Such holes are called burrows.

HEAD.—TEETH.

1. On what does a rabbit usually feed? Green herbs such as clover, lettuce, cabbage, carrots, dandelion, &c. Have you ever watched how the rabbit bites either its food or the wooden bars of its hutch? It takes small, quick bites with its long front teeth. Why can these teeth be so easily seen? Because the upper lip is divided. Now can you think of any reason why this upper lip should be so divided? If the lip were not divided it would often be in the way of the biting.

2. This kind of biting is called *gnawing*, and it will be interesting to see what kind of teeth the rabbit has with which to gnaw its food or its hutch.

3. Let us look then at a rabbit's skull; it will be observed:—

(*a*) There are front teeth and cheek teeth, with large empty gaps between.

(*b*) The front or gnawing teeth consist of two at the top and two at the bottom.

Look behind the upper teeth:—

(*c*) There is a pair of teeth behind the upper teeth, making *four teeth at the top.*

4. But the shape of these teeth is more peculiar than their number. Notice that they are very sharp, with an edge like a chisel. The fact is, they are made after the manner of a chisel; the outer side is harder than the inner, and so the softer side wears away faster, leaving the harder side longer. More than this, as the teeth wear away they continue to grow, and so keep to the same length beyond the gums.

5. At which end will these teeth grow? Think; where do our nails grow? At the lower end. Just in the same way the rabbit's teeth are added to at the end within the jaw, and are gradually pushed forward as they wear away. Notice the great

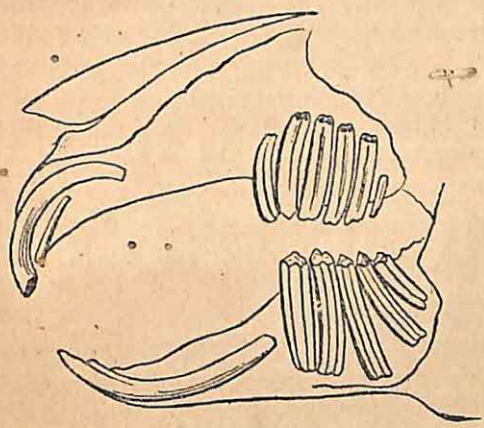


Fig. 17. Section of Rabbit's Skull to show position of teeth. Notice small tooth behind large upper front tooth.

length and shape of them as shown in Fig. 17. Perhaps you may be able to take those out of the skull you have examined.

6. Notice the eyes. They have an inner lid, which is moved from the side.

MOUTH.

1. If we now return to the living specimen, we may notice:—

(*a*) Whiskers or feelers, to enable the animal to go about in the dark.

(*b*) Some strong hairs inside the cheeks.

The rabbit often bites bark off trees and wood; if its cheeks were not protected, they might be cut by the rough food as it is taken in and passed to the grinders. The hairs therefore protect the cheeks.

2. It may be noticed too, that if a tooth gets broken, the opposing one continues to grow and is not worn away, the consequence being that the animal's mouth may get into such a state that it cannot eat for the overgrown tooth.

HOME AND HABITS.

1. Rabbits, when wild, live in burrows. They like a sandy hillside, wood, or field, and many burrows together form what is called a *warren*.

2. The chief foes of the rabbit besides man are stoats, weasels, eagles, and kites. Cats also might be included. A burrow has often several entrances, to furnish ways of escape from animals that may enter it, like the weasel.

3. We have referred to the *grey colour* of wild rabbits, but black, and even white ones, are sometimes born amongst them. Now which do you think would be most readily observed by the rabbit's foes, the black or grey? There is no doubt the black would show up on a sandy field or leafy wood. Which therefore would be most likely to be shot or caught first? The black ones. What use, then, is the grey colour? Rabbits of a grey colour have the best chance of escaping their foes, so the rabbits that survive are mostly grey.

4. Have you ever noticed, when rabbits are disturbed and go hopping away, what is very plainly seen? The *white* of the under side of the *tail*, which they always turn up when running. Often a rabbit is only seen by the white bobbing tail. Why then should it so betray its presence? The most likely explanation seems to be that the white tail is a signal to the young and the others that danger is about, and that they must follow, for, be it remembered, the rabbit when alarmed never utters any sound.

Note—The hare is larger than the rabbit; it can run much faster, and never burrows, but makes a nest called a *form*.

LESSON XV.

THE SQUIRREL.

This lesson is taken in preference to one on the Beaver, because the Squirrel is a native, and it may fairly be assumed that a living or stuffed specimen would in most cases be able to be procured; failing that a good picture is necessary.

HOME.

1. The squirrel is a very pretty little animal that often frequents our woods, living, not on or in the ground, but amongst the branches of the trees.

2. Here it finds its food in the form of nuts, beech-masts, young shoots, and even occasionally birds' eggs.

3. It makes itself a nest in the fork of a branch, or in a hole of a tree, and for a part of the winter goes to sleep, having first stored up food in various hiding-places or cupboards.

BODILY CHARACTERISTICS.

1. We will now look more closely at this engaging little creature; observe:—

(*a*) The squirrel's body is covered with reddish-brown fur.
(*b*) It has a fine long bushy tail which it curls up its back.
(*c*) When it eats a nut it sits up on its hind feet and holds the nut in its fore paws as though they were hands.

2. Look now at the feet;—

(*a*) The hind feet are large like the rabbit's.
(*b*) The squirrel has five toes on each hind foot, but only four on each fore foot.
(*c*) Each toe has a strong claw which cannot be drawn in.
(*d*) The hind legs, like the rabbit's, are longer than the fore legs.

Fig. 18. Squirrel in the act of walking.

3. Now observe the head :—

(*a*) The ears are quite upright with a long tuft of upright hairs at the end of each.
(*b*) The upper lip is divided like the rabbit's.
(*c*) The teeth, like the rabbit's, are *gnawing* teeth.
(*d*) They are long and chisel-like, (but there are only two upper front teeth, and not four as in the rabbit).
(*e*) The inside of the mouth is like that of the rabbit.

4. The squirrel uses its teeth exactly as the rabbit uses its teeth, but when it wants to get the kernel of a nut, it first makes a small hole and then breaks the hard shell away bit by bit till the kernel is clear.

HABITS.

1. Of these we have spoken in the introduction, but there are one or two points to be added. Squirrels are very active amongst the branches of the trees in our woods and plantations. They spring lightly from branch to branch, and seldom go down to the ground.

2. If, however, they have to descend to get to other trees at some distance, away they jump out into the air with their legs and tail spread out and fall on the ground quite lightly. How can they do this ?

3. Take a sheet of paper and let it fall from the hand while held in a horizontal position. Now double the paper twice and similarly let it drop ; what difference is observed in the fall ? When the paper was more spread out it fell more lightly. Why ? Because being larger there was more air under it to hold it up, while at the same time it was no heavier than when folded up.

FLYING SQUIRRELS.

1. There is a kind of squirrel found in Africa which has a good deal of loose skin between its hind and fore legs along each side of its body.

2. When this animal jumps and spreads out its feet the loose skin is stretched, and so a large flat surface is formed which is

held up much by the air underneath, and the animal is able to jump much greater distances. Such are called flying squirrels.

SUMMARY.

1. Like the rabbit, the squirrel is a gnawing animal.
2. Unlike the rabbit it spends its life amongst the branches of the trees.
3. It feeds on nuts, stores up food, and sleeps during part of the winter.
4. Some are called flying squirrels.

LESSON XVI.

RATS, MICE, AND BEAVERS.

Pictures or stuffed specimens of any Rodents, or living specimens of white rats, guinea pigs, or mice.

RODENTS.

1. Although the rabbit and the squirrel are in many ways unlike each other, especially in their homes, yet in certain important points they resemble one another; such are:—

(*a*) The rabbit and squirrel both live on vegetable food.
(*b*) Both have chisel-like front teeth which they use in gnawing.
(*c*) Both have claws alike.

2. It is, however, the *gnawing* that we shall most notice, for in this they are like a number of other animals which all have the same kind of teeth and gnaw in the same manner. They are generally called by a name which means *Gnawers*, and that is *Rodents*.

RATS AND MICE.

1. These animals are well-known everywhere, and comparisons may easily be made:—

(*a*) A rat is about half the size of a small rabbit.
(*b*) A mouse is much smaller than a rat.
(*c*) Both are covered with a dark grey or brownish fur.
(*d*) Both have long naked tails.
(*e*) Both have pointed noses and sharp teeth, with which they *gnaw* holes in wood.
(*f*) The long sharp nose shows us their scent is keen.
(*g*) Mice live in houses; rats in various places, especially in corn-stacks and drains.

Fig. 19. Nest of Harvest Mouse.

(*h*) Both animals eat chiefly corn, but rats will devour eggs and chickens.

2. In fact, it may be noticed that the teeth of both these animals are, as might be expected, of the gnawing or chisel-like kind, and the claws are sharp like the squirrel's and rabbit's. They are therefore called *Rodents*.

3. Rats and mice would become a plague if they were not kept down by other animals that eat them as their prey.

BEAVERS.

1. Here is another animal that looks in many ways different from those of which we have just been speaking. It does not now live in England, but may be found very plentifully in North America. Notice from the picture :—

(*a*) The beaver is a larger animal than a rabbit.
(*b*) It lives near or in water.
(*c*) It has a broad tail.

2. But the picture will probably show a beaver *gnawing* a tree. Notice the teeth; they are long and chisel-like.

3. Here, then, we have another Rodent. With their teeth beavers gnaw down trees that grow on the banks of streams, so that the trees may fall into the water, and by damming it up, form a large pool in which they build their nests. These nests are built of sticks and mud, and being situated in the water the beavers must be able to swim to get to them; and here we see the need for the broad flat tail.

4. Of their nests it may be noticed :—

(*a*) They are placed so as to be safe from land animals.
(*b*) The beavers in their nests are out of reach of foes that cannot swim.
(*c*) The dam saves the nests from being washed away.
(*d*) The entrance to each nest is under the water.
(*e*) The nest looks like a large ball of mud and sticks, standing partly out of the water.

5. We thus see :—

(*a*) Beavers are Rodents.
(*b*) They differ from squirrels, rabbits, rats, and mice, in living near water, and being able to swim readily.

The beaver swims with its tail, but builds up the mud of its nest or lodge with its fore feet. The hind feet have a thin skin between the toes, joining them together. What is the use of this? To aid the animal in swimming, for the feet can then better press against the water to help the creature along.

OTHER RODENTS.

1. We have then noticed the following Rodents or Gnawers:—Rabbit, squirrel, mouse, rat, beaver; a few others should be compared with these.

2. **Harvest Mice** and the **Long-tailed Field Mice** are pretty little creatures, and quite gentle when caught, not fierce or savage like the rat and house mouse.

3. **Water Voles** are often called water rats. They are pretty, harmless creatures, and very timid. **Field Voles** are as small as mice, but have short tails, and are often found in great numbers together.

4. **Hamsters** are larger than rabbits. They are found in Germany, where they lay up great quantities of corn in their nests for the winter.

5. **The Dormouse** is a pretty little creature often found in our woods. It has a squirrel-like tail, and it takes its name from the fact that it sleeps the winter through.

6. **The Guinea Pig or Cavy** is kept as a pet, and not found wild. It is not a pig, and does not come from Guinea.

LESSON XVII.

THE MOLE.

Stuffed mole; skeleton or dried specimen such as may be obtained after being impaled on a fence or wall; skin of mole; piece of velvet; drawings to show shape of the animal and the arrangement of habitation.

GENERAL APPEARANCE.

1. Here is a curious animal; more like a piece of velvet than any animal we have yet observed. Notice:—

(*a*) It has a rounded body with a pointed nose and a short tail. (*Make a sketch of shape.*)
(*b*) The legs are very short.
(*c*) It is covered with a coat that looks like black velvet.

This is called a mole.

HOME OF THE MOLE.

1. Most children who have been out in the fields will have seen the small hillocks of fresh earth that appear to have been thrown up generally amongst the grass. These are mole hills, and have been thrown up by moles burrowing underneath.

2. Farmers do not like these mounds, but set traps to catch the moles. To do so they move some of the loose earth until they come to the burrow or "run," along which the moles are sure to go at some time, and then they place the trap so that a mole may be caught in running along.

3. Moles' runs pass in various directions, but always lead to a nest somewhere in the earth. These nests are made in a very puzzling way, quite like a maze, so that if a mole is pursued by

some other animal, it can easily escape. On page 82 is a plan of one, which will be best understood with the aid of a model made of wire.

Notice :—

(*a*) The upper circle or tunnel.
(*b*) The lower and larger circle.
(*c*) The passages or tunnels leading from the upper to the lower one.
(*d*) The nest in the centre below the lower circle.
(*e*) The tunnels leading down to the nest.
(*f*) The tunnels leading from the lower circle away from the nest.
(*g*) The tunnel from the nest to one of the last-mentioned tunnels.

FOOD OF THE MOLE.

1. We are led then to ask why the mole has these runs underground, and why it has such a dwelling. A little thinking will show us :—

(*a*) The mole's dwelling is a very clever construction for its safety.
(*b*) The mole probably goes underground to seek its food.

2. That leads us to enquire what the food of the mole is. The mole does not come out of its burrow, but finds in the soil what food it requires in the shape of worms, young beetles, and other insects which are always to be met with there. In eating these things moles often do much good, and unless there are too many of them it is probably a mistake to kill them.

STRUCTURE AND ADAPTATION.

1. Having learnt, then, something of the kind of life the mole leads, we will examine it more closely, and see how it is fitted for this life. Notice :—

(*a*) The body is rounded, and pointed at the nose. Why? So that it may pass through the soil more easily.
(*b*) The legs are very short indeed. Why? So that it may travel easily in a small tunnel without requiring room for its legs.
(*c*) The feet (especially the fore ones) have five toes armed with very strong sharp claws. Why? To enable the mole to dig out the earth.
(*d*) The fore feet turn sideways. Why? So that the mole can throw the earth *behind* as it digs, and not *under* its body, as a rabbit would.

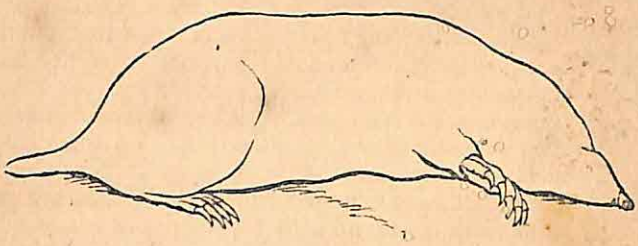
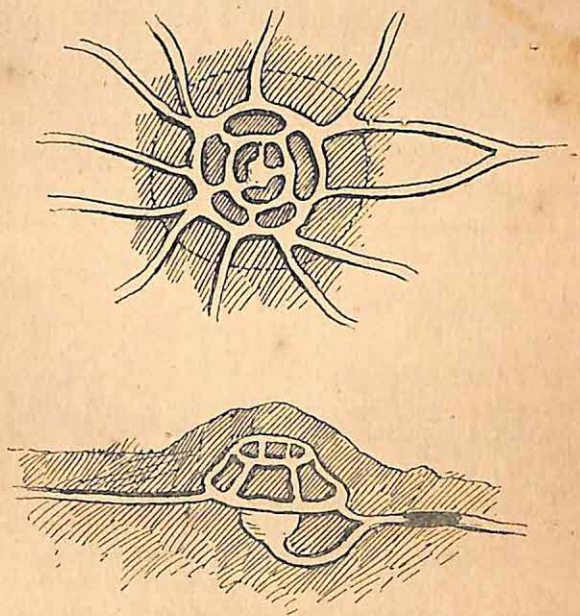


Fig. 20. Outline of Mole.



21. Fortress of Mole. Plan and elevation.

(*e*) The fore legs are very thick and strong. Why? Because they have much heavy work to do.

(*f*) The mole's coat is like velvet, and can be stroked any way equally well. Why? Being so, it is not likely to become soiled or prevent the mole from going either backwards or forwards as it pleases.

(*g*) The eyes are exceedingly small. Why? The mole has no use for eyes underground, and perhaps only needs to distinguish light from darkness.

(*h*) No ears can be seen. Why? Open ears would be in danger of being choked up with earth. Yet the mole's hearing is very keen.

(*i*) The teeth are very sharp. Why? To eat up the worms and other such food.

2. We thus see that the mole is especially fitted in many ways for a life in the darkness in the soil of the earth, where it is able to find all the food it requires.

COMPARISON.

1. If we compare the mole with other animals we have studied, we see :—

(*a*) It resembles the rabbit in its burrowing habit.

(*b*) But in all other respects it is more like the flesh-eating animals, the cat and dog.

2. Its teeth, it is true, are somewhat like the cat's, but not quite so, and it differs in :—

(*a*) The large hand-like feet.

(*b*) Walking on the whole foot and not on the toes.

3. The food, too, though a kind of flesh, is never so called, but the mole is said to be an *insect-eating* animal.

SUMMARY.

1. The mole lives entirely in the earth, and feeds on worms, especially wire-worms, which are the young of a kind of beetle.

2. Mole hills are the earth thrown up out of the tunnels made by the mole. This throwing up lightens the soil.

3. The mole's body is especially formed for its underground life in the following ways :—

(*a*) The shape of the body and shortness of the legs.
(*b*) The strength of the fore legs and the way the feet are turned.
(*c*) The sharpness of the claws.
(*d*) The velvety coat and the small eyes.
(*e*) The ears being hidden.
(*f*) The sharpness of its teeth and the quickness of its hearing.

LESSON XVIII.

THE HEDGEHOG.

A living or stuffed specimen; picture.

DESCRIPTION.

1. When you see a hedgehog for the first time it will probably look like a ball of thorns or spines. Watch it awhile, and it will gradually unroll. If it does not, put it into a bowl of water, when it will quickly do so. By this time sufficient will have been seen to write down :—

(*a*) The nose is long and pointed.
(*b*) The legs are short and the toes clawed.
(*c*) The upper part of the body is covered with sharp spines.
(*d*) The under part is clothed with hair.
(*e*) Both eyes and ears can be seen plainly.

2. If the animal is now placed on the table and touched, it will at once draw its nose under its body between its fore feet, and become a ball of spines again. In doing so the skin of the back is stretched and the spines are spread out a little, so that if you were touching the animal at the time you might be pricked.

3. NAME. Observe the nose; it bears some slight resemblance to that of a pig or hog, hence it is called a hedge *hog*.

HOME AND HABITS.

1. From the other part of its name, then, we may infer that the animal is found in hedges; and this is the case, for in such places it makes its nest of hay and moss. It does not burrow like the mole, and we can see one very good reason why it does not—its coat of spines would be altogether unsuited to travelling through tunnels underground.

2. Its food consists of worms, insects, especially beetles, small frogs, mice, and even little snakes, which it devours with its

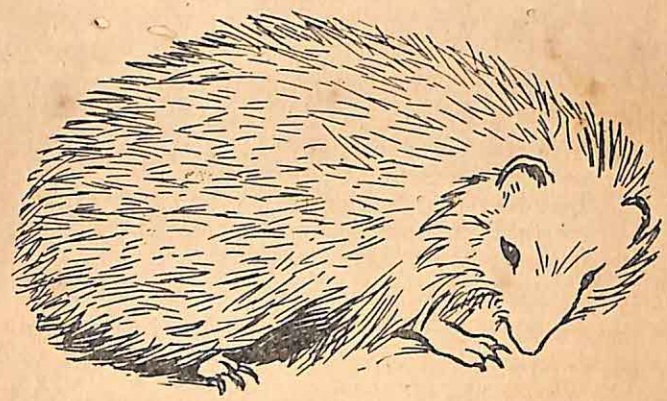


Fig. 22. The Hedgehog.

sharp teeth. Sometimes hedgehogs are kept in houses to eat beetles and cockroaches, and they become very tame.

3. The hedgehog sleeps by day and comes out for food at night. Like some animals we have already spoken of, it sleeps through the winter. It eats well during the summer, and becomes quite fat; then it hides away in its nest and sleeps till the warm spring weather comes. This habit, which is also practised by the squirrel and dormouse, is called *hibernation.*

4. The hedgehog is a very harmless creature; it never attempts to bite a foe or even to run away from one. Why? It can defend itself by rolling up and leaving nothing outside but its spines. Neither dog nor cat can unroll it.

COMPARISON WITH MOLE.

1. Like the mole:—
   - (*a*) The hedgehog feeds on worms and insects.
   - (*b*) It is a small animal, but somewhat larger than the mole, being about 10 in. long, while the mole is not more than six or seven.
   - (*c*) The legs are short.
   - (*d*) It has five strong claws on each foot, though it does not burrow.
2. Unlike the mole:—
   - (*a*) The hedgehog has eyes and ears which are plainly seen. Why? It does not burrow, but lives above ground.
   - (*b*) The feet are not turned sideways. Why? It is not necessary, because they are not used for digging and scooping out tunnels like the mole's.
   - (*c*) The covering is spiny, not soft and velvety. Why is this difference? (1) The hedgehog's spines are its means of defence, but the mole's nest and tunnels are its protection. (2) The mole's coat is suited to running about in underground passages, but the hedgehog's would never do for this purpose.
   - (*d*) The hedgehog hibernates. Why? Because its food is not to be found above ground in winter.
3. So, though both are *insect-eaters*, they lead very different lives, and each is formed for the kind of life it leads.

Note.—The Porcupine, with its long quills, is sometimes thought of with the hedgehog, but it is a very different animal, being a *rodent* like the rabbit, squirrel, and beaver.

LESSON XIX.

THE BAT.

Stuffed specimen; drawings of skeleton and bat's wing; pictures (see "Jarrolds' Illustrations of the Animal Kingdom," Sheet No. 3).

WHEN BATS ARE SEEN.

1. Often in the dusk of a summer evening we may see small creatures flitting about on the wing, darting hither and thither, almost striking us in the face, but wheeling suddenly and silently away before we can form any idea as to what kind of creatures they are, further than that they somewhat resemble swallows in their flight. But swallows are all at this time resting for the night.

2. If we would catch one we must look in some barn or church tower during the day, when we may be lucky enough to find some of them asleep under the roof or hanging from the rafters or cross beams. Such are bats.

DESCRIPTION.

1. From a stuffed or living specimen it may be observed :—

(*a*) The bat's body is small and covered with fur.
(*b*) It has large wings of a kind of leathery skin.
(*c*) It looks like a mouse with wings.

2. The old name for this creature was *flitter-mouse*, and a very good name it was, for its body is much like that of a mouse. Observe the head :—

(*a*) The ears are large.
(*b*) The mouth is large and full of sharp pointed teeth.

These are not like a mouse's, for it will be remembered we

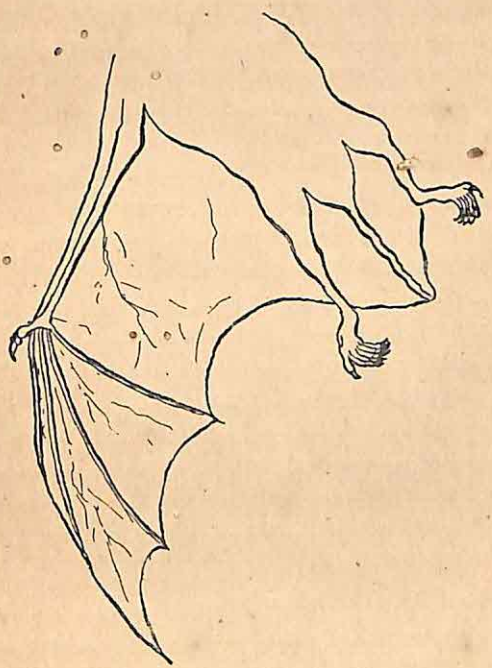


Fig. 23. Bat's Right Wing. The small hook at the top represents the thumb, and the ribs the fingers.

saw the mouse was a Rodent, with two pairs of front gnawing teeth. Notice the eyes and nostrils.

WINGS.

1. However much the bat may be like a mouse in other respects, it differs entirely from it in having wings. Notice :—

(*a*) The wings stretch from the hind to the fore legs.
(*b*) They look like a piece of an umbrella stretched by ribs.

2. Examine one of the wings. Here is a drawing of one. Observe the fore leg or arm :—

(*a*) The upper arm and elbow.
(*b*) The lower arm.
(*c*) From what looks like the wrist, spread the long "ribs."

What are these? How many are there?

(*d*) There are four "ribs" in the wing, and a shorter one ending in a strong claw outside.

3. Are not these like long fingers? Let a boy imagine his fingers to have grown as long as his arms, the skin to have grown between them and from his arms to his sides, and he will get some idea of how the bat's wing is formed.

4. The bat's wing is a skin or *membrane* stretching between the fingers from the arm to the leg, and so on to the tail on each side. Notice :—

(*a*) The thumb is free with a hooked claw.
(*b*) The feet are free.

5. The bat* most commonly seen in England has a body about 1⅜ inches in length, but the spread of its wings is eight inches. Some foreign bats are larger; one called the fox bat measures *five feet* across the wings.

FOOD AND HABITS.

1. English bats feed on insects, and they come out at dusk, when most other catchers of flying insects are gone to rest, so that they have the field almost to themselves.

---

* The pipistrelle.

2. The bat cannot walk, except in a very awkward manner, so it generally alights on a tree or beam, and holds on by the hook-like thumb. When it goes to sleep, as it does in the day time, it hangs by its feet, head downwards.

3. But what will the bat do for food in the winter when no insects are to be found? What does the hedgehog do? It hibernates. So does the bat.

4. The mother bat has one or two young ones at a time, and these she suckles as do all the other animals of which we have so far spoken. She often carries them about with her as she flies to catch insects, the young ones holding on to her breast.

5. The bat has its sense of feeling very keen, and however close it may fly to anything it will never knock against it, for even when it cannot see, it seems to feel before touching, and to turn away at once.

SUMMARY.

1. A bat looks like a mouse in having:—
   (*a*) Body covered with fur.
   (*b*) Ears, nose, mouth, and teeth.
2. But it is unlike a mouse in having:—
   (*a*) Teeth not made for gnawing.
   (*b*) Hands and arms formed into wings.
3. The bat is like the mole and hedgehog in being an *insect-eater*, but:—
   (*a*) The mole finds its food in the soil, and is formed for life underground.
   (*b*) The hedgehog finds its food on the ground, and is formed to defend itself against many foes; while
   (*c*) The bat finds its food in the air, and is formed for flying, its rapid flight being its chief means of protection from foes.
4. The bat hibernates like the hedgehog when there is no food to be found.

LESSON XX.

SOME ANIMAL COATS:

AND THE USES THEY ARE PUT TO.

Piece of rabbit skin with fur on, cat skin or other fur; piece of dog skin or goat skin; wool, cow hair, horse hair; mole skin, velvet.

CLOTHING.

1. The animals we have been talking about are kept warm by clothing which grows on their bodies and needs no making like ours; we have noticed:—

(*a*) The *hair* of the dog, horse, and cow.
(*b*) The *fur* of the rabbit and cat.
(*c*) The *wool* of the sheep.
(*d*) The velvet of the mole.
(*e*) The spines of the hedgehog.

2. Some animals need little covering; the elephant is one of these and the pig is another.

KINDS OF CLOTHING.

1. Let us now compare some of these different kinds of coats, and see in what way they are unlike or like each other. Take a piece of goat skin and compare with rabbit's fur:—

(*a*) The hairs are long.
(*b*) They lie in one direction.
c) The rabbit's fur consists of hairs which stand straight out.
(*d*) Some hairs of the fur are longer than others.

2. Look a little more closely and you will see that the long hairs of the fur are few while the short hairs are very thick. The difference between fur and hair consists mainly in this, that

hair lies or has a "set" (sometimes it is curly), while fur stands out straight from the skin, and consists of long hairs and closer short hairs. Fur is soft, hair is often harsh, and can only be stroked one way. Try the coats of the dog, horse, and cow.

3. But there must be some reason why a rabbit's fur is made up of long and short hairs. It is very likely that the longer hairs :—

(*a*) turn off the water, and
(*b*) prevent the shorter hairs from becoming matted.

4. Look now at a piece of sheep's wool; notice :—

(*a*) Wool is made up of many fine hairs.
(*b*) These hairs curl together into a mass.

5. Thus we see :—

(*a*) *Hair* (so called) consists of hairs fine or coarse having a "set."
(*b*) *Fur* consists of fine hairs without curl or set.
(*c*) *Wool* consists of fine hairs which curl together.

6. It only remains to notice the velvet of the mole :—

(*a*) The mole's skin is covered with short fine hairs.
(*b*) These stand out straight and have no "set."
(*c*) They are of equal length, and can be stroked any way like velvet.

The mole's velvet then may be called a kind of fur.

EXAMPLES.

1. Let us now write down the names of some animals whose covering consists of hair, fur, or wool.

(*a*) *Hair*—horse, cow, dog, reindeer, goat.
(*b*) *Fur*—cat, rabbit, squirrel, beaver, rat, mouse.
(*c*) *Wool*—sheep.
(*d*) *Velvet*—mole, shrew.

2. Notice the fact that animals in cold countries need warmer coats, and the colour is often a means of defence, because it makes the animal to be less readily seen.

USES TO WHICH APPLIED.

1. Useful as are all these coverings to the animals that bear them, they become equally useful to us when taken off.

2. Skins covered with hair are used as rugs. Cow hair is used in plaster; horse hair for furniture.

3. Skins covered with fur are used for clothing or trimming clothing. Many kinds (called furs) are brought from Russia and America, where, the climate being severe, the animals seem to need a warm covering.

Rabbit fur is made into *felt* for hats.

4. Wool as we have seen is made into cloth for our clothing.

Thus the coverings of hair, fur, and wool protect the animals on which they grow during life, and when their owners are dead we turn them to an equally good account for ourselves.

LESSON XXI.

TEETH AND FEET.

Specimens, pictures, and drawings of the teeth and feet of flesh-eaters, ruminants, and other animals treated of in the foregoing lessons.

TEETH AND FOOD.

1. Here we have some teeth; notice there are three kinds:—
   (*a*) Large broad teeth with flat grooved tops.
   (*b*) Smaller sharp-pointed teeth.
   (*c*) Long thin curved teeth with chisel-like tops.

2. These three kinds belong to three different kinds of animals. From what has been learnt in some of our previous lessons, it will be easy to say why different animals require different kinds of teeth, and what sort of animals each of these sets belongs to:
   (*a*) Broad flat teeth are best for grinding corn or chewing grass.
   (*b*) Sharp pointed teeth are best for seizing, holding, tearing and cutting up flesh.

3. We have already seen what kind of food is eaten by several animals.
   (*a*) The cow and horse eat grass, and require broad grinding teeth.
   (*b*) The cat, dog, lion, and tiger eat flesh, and therefore require tearing and cutting teeth.
   (*c*) The rabbit and squirrel eat plants, nuts, and bark of trees; they need very strong sharp teeth.

4. Now these teeth we have here are:—
   (*a*) The grinders of grass-eaters (cows).
   (*b*) The tearing teeth of flesh-eaters (cats).
   (*c*) The gnawing teeth of gnawers (rodents).

And we see that these animals have each just the kind of teeth needed for eating the food on which they live.

FEET AND FOOD.

1. But if animals live on certain kinds of food, and each has teeth suited only for eating one kind of food, they must be able to seek their food; and the better they can do this, the better chance will they have of doing well. What then must we look at to see how they are enabled to do this? Their feet.

2. Well, let us take the three classes mentioned above and consider their feet:—

(*a*) The cat lives on prey, and has sharp claws for catching it.
(*b*) The cat is also able to hide its claws, to steal along softly, and then to dart them out suddenly.
(*c*) The dog has claws, but does not use them for seizing; it depends on running and its teeth.
(*d*) Lions and tigers have feet and claws like the cat.
(*e*) The flesh-eaters then have feet suitable for helping them to catch living animals; so the feet are made to help the teeth.

3. Now where does the cow find her food? In fields. It needs no catching, no running after. The same is true of the sheep and goat, though they sometimes have to wander far. These all have to walk on ground that is sometimes soft. Their feet are two-toed and hoofed. Such feet as these, being broad and spreading, will not sink far into the ground. (Compare what was said of the camel's feet.) Thus then we conclude:—

(*a*) Grass-eating animals have broad-hoofed feet for walking on soft ground.
(*b*) In this case also the feet help the teeth.

4. But this can hardly be said of the rabbit. Its feet are rather used to help it to make its home or burrow, and it relies upon its teeth for food, except to this extent that it is able to hop or jump at a pretty good speed. But the squirrel and beaver use their feet to get their food, and to seek protection, to a greater extent:—

(*a*) The squirrel in climbing.
(*b*) The beaver in swimming.
(*c*) The water vole in swimming and burrowing.

THE BAT AND MOLE.

1. There are two other animals of which we have spoken, the bat and mole, not to mention the hedgehog. What is their food? Insects. And what kind of teeth have they? Sharp teeth somewhat like those of the flesh-eaters. Now how do their feet help them? :—

(*a*) The mole's feet are used for digging, and in the ground it finds its food.

(*b*) The bat's hands are wings, and in the air it finds its food.

DEFENCE.

1. Claws which serve so well for catching prey can also be used for protection, and animals like the cow and deer, that have no claws, have another weapon, viz., their horns. The hedgehog depends on its spines, and the horse on the use of its heels or hind feet.

SUMMARY.

1. Animals have teeth formed for eating the kind of food suitable for them, and feet to enable them to seek it.

(*a*) Horses, cows, sheep, &c.—grass teeth and hoofs.

(*b*) Cats, lions, tigers—flesh teeth, and sharp claws that can be drawn back.

(*c*) Rodents—gnawing teeth and sharp claws.

(*d*) Bats and moles—sharp teeth, and special feet for seeking worms and insects.

LESSON XXII.

THE HEN.

A living bird, feathers, bones of wing, wing with feathers, skeleton of head; picture; drawings of feather, wing, beak, and foot.

GENERAL CHARACTERS.

1. Everybody knows the common hen so well, that even if you have not a living specimen before you, a good picture will readily call up what must have been often seen. The hen lays the eggs that we eat.

2. Let us then compare a hen with other animals which we have learnt something about, and some most remarkable differences will be at once observed :—

(*a*) The hen's body is covered with feathers.
(*b*) The hen has two legs and two wings.
(*c*) The hen has a beak to peck with.
(*d*) The hen uses her feet for scratching and her wings for flying.

FEATHERS AND FLYING.

1. The most important differences then seem to be seen in the *feathers*, *wings*, and *beak*. Let us study these a little and see what we can learn about them. Taking first the feathers, we notice :—

(*a*) The whole body, except the lower part of the legs and the feet, is covered with feathers.
(*b*) Feathers are of two kinds—large strong feathers and small *downy* feathers.

2. Now here is a hen's wing. Notice the large feathers; here is one of them; take it and observe :—

(*a*) The feather has a strong shaft or quill which runs through the middle from end to end.

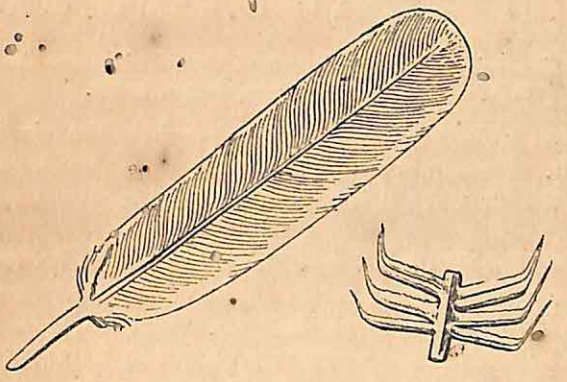


Fig. 24. Feather; a portion of one enlarged.

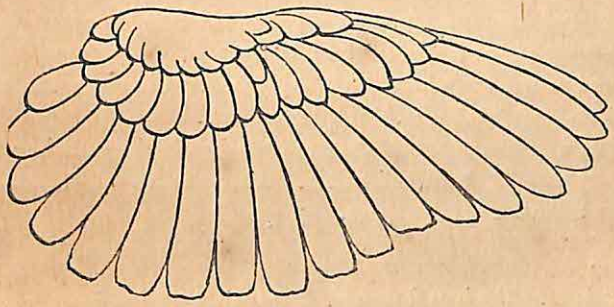


Fig. 25. Bird's Wing spread.

Fig. 26. Hen's Beak.

(*b*) Fine flat pieces branch off on both sides all the way up.
(*c*) These pieces interlock together, so that they do not easily separate.
(*d*) The sharp point at the bottom of the quill is where the feather is fastened in and grows from the bird's skin.

3. Wave a feather about, and notice how the air presses against it. Spread out a wing; it is like a fan; notice the pressure of the air when it is waved, especially against the curved side.

4. Now, *how does a bird fly?* If a boy stands between two tables or two desks and presses down on them very hard with both hands, he will raise his body up. When a man rows a boat, he presses the oars against the water and the boat is urged forward. When a swimmer swims, he advances by pressing his hands and feet against the water. In the same way a bird rises in the air by *pressing down* on the air. The wings when spread are hollowed underneath, and so the air below presses more against a downward stroke than the air above presses on the upper side when the wings are being lifted. Compare the wind against an open umbrella.

5. It is well known what a warm covering feathers make; they also very readily turn off water. There is an oil formed to moisten them for this purpose.

WINGS.

1. It is true the hen does not fly much, not, for instance, like the rook, but she can fly short distances; the wings are assisted by the spread of the tail, and, in fact, all the feathers of the body.

2. But what are these *wings?* We have seen that the hen has only two feet, but she has *four* limbs; that is, instead of fore and hind legs, she has wings and feet. So we see these *wings* are in the place of *arms* or fore legs; and if you could see the skeleton or bones of a wing, you would see that they are just like the bones of an arm or fore leg, but that instead of the bones of the *hand* or fore foot, there are just a few bones to correspond to the thumb and first two fingers; and it is from these limbs that

the quill feathers grow. In this use, then, of the fore limbs, what are we reminded of? The bat. But in the bat the finger bones could all be well seen; and there were no feathers, only skin or membrane between the fingers.

3. Our conclusions are:—

(*a*) The hen walks on her hind feet.

(*b*) The arms or fore legs are covered with quill feathers, and are used as wings for flying.

HEAD.

1. Now observe the head:—

(*a*) The hen's head is small, and the eyes are placed on the sides.

(*b*) Behind the eyes are small ears.

(*c*) On the top of the head is a naked comb, and below the eyes are wattles. These are larger in the male bird.

(*d*) The lips grow hard, horny, and pointed, and are called a beak or bill.

(*e*) In the mouth there are no teeth.

2. What is the hen's food? Usually grain, and this is easily picked up by the sharp pointed beak.

FEET.

1. We have seen in the case of some animals the feet assisted the mouth in getting food, and this is so here. Look at the feet:—

(*a*) Each foot has four toes, three forward, one backward.

(*b*) This arrangement of the toes enables the hen to rest on a perch.

(*c*) Each toe has a horny nail or claw at the end.

(*d*) With these claws the hen scratches the ground in search of food, and so the feet assist the beak.

2. As the hen has no teeth to chew her food, she has a special stomach called a gizzard, full of small stones, and through this the food passes and is ground up as by teeth.

LESSON XXIII.

THE DUCK.

A living or stuffed specimen or picture; drawings of head and feet.

FORM AND HABITS.

1. In this lesson we are going to try to learn something about a duck. A few questions as to where ducks are usually seen, and under what circumstances, will bring out :—

(*a*) Ducks are often seen swimming on water.
(*b*) They often seek muddy places.
(*c*) Sometimes they are seen with their heads in the water, as though trying to find something at the bottom.

2. But when the duck walks on land some of its peculiar characteristics will have been noticed :—

(*a*) Ducks are larger than most hens, but not so large as geese or swans.
(*b*) When walking, the duck's body seems to be very heavy, and its legs very short.
(*c*) Ducks are usually white or grey.
(*d*) They lay larger eggs than hen's eggs.
(*e*) Young ducks are pretty little downy creatures, and are called ducklings.

SWIMMING.

1. If a duck has been watched when swimming, it will have been noticed that it uses its feet to propel itself along. Recall what was said of flying and swimming in the last lesson. Look at a duck's foot :—

(*a*) The duck has toes like the hen, but
(*b*) The toes are joined together by a skin or membrane.

2. Such feet as these are called *webbed* feet. Compare with

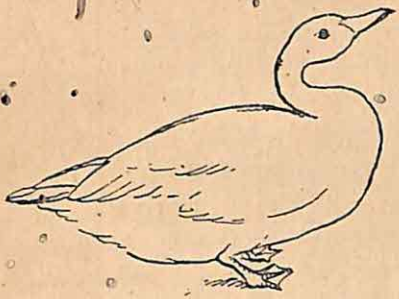


Fig. 27. Outline of Duck.

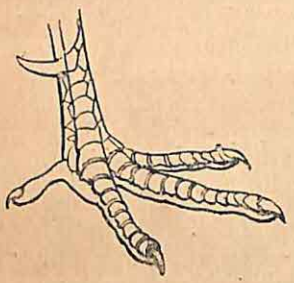


Fig. 28. Hen's Foot.

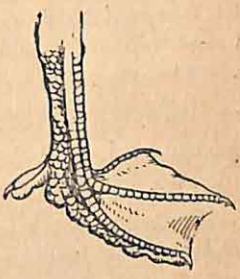


Fig. 29. Duck's Foot.

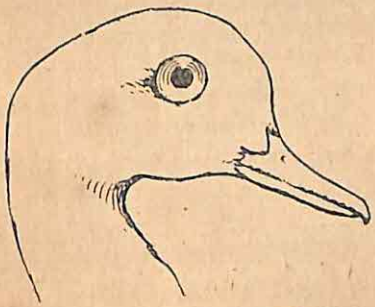


Fig. 30. Duck's Head and Beak.

the hen's feet, which we saw were used for scratching and perching. The duck can do neither of these things, for its feet are not formed for the purpose, but for swimming, and walking about where the ground is soft and muddy.

3. Notice, too, the position of the legs:—

(*a*) The legs are short and set far back.

This arrangement makes it easier for the duck to swim, for, as we have seen, the feet are pressed against the water to urge the body forward, and it is easier to get on with the greater part of the body in front of the legs than it would be if the legs were set in the middle of the body.

4. Notice too the wings:—

(*a*) They are large, but not in proportion to the weight of the body.
(*b*) A duck seldom flies but wild ducks can fly easily for considerable distances, as much as half a mile at a time.

FOOD.

1. Let us now look at the duck's bill and consider what uses it is suited for. Compare with the hen's bill:—

(*a*) The duck's bill is broad and nearly flat.
(*b*) It cannot be used for pecking.
(*c*) It is called a spoon-shaped bill, and is used for shovelling up food.

2. Where does the duck find its food? In mud and in water. Ducks are often seen taking up mouthfuls of mud and squeezing it out at the sides of their long flat bills. They are feeling for worms. Sometimes they dive for these, or for fishes or frogs, to the bottom of the water. In what special way are they formed so as to be able to do this easily? They have long necks.

SUMMARY AND GENERAL REMARKS.

1. The duck, like the hen, is called a bird. Its body is covered with feathers, its fore limbs are wings, it walks on two legs, and its lips are in the form of a beak. It has no teeth.

2. The duck's feet are :—

(*a*) Not formed for scratching or perching,
(*b*) but for paddling and swimming.

3. The food of the duck is found in water or mud, and its beak is fashioned for the purpose of taking it up from such places. We therefore see :—

(*a*) The body and feet are formed for water life.
(*b*) The food is found in or about water.
(*c*) Therefore the bird is suited to the life it leads.

OTHER SWIMMERS.

1. As the duck differs chiefly from the hen in being formed for swimming and finding its food about water, it will be interesting to call to mind other swimming birds, such as the goose and swan.

LESSON XXIV.

THE OWL.

Stuffed specimen or picture; drawings of beak and claws.

GENERAL APPEARANCE.

1. Here is a strange-looking bird, only like a duck in having feathers, wings, a beak, and two feet. Yet these all differ from those of the duck.

2. But what is the most striking feature? Its eyes. See what large round eyes it seems to have. It is true they are large, but they seem larger, owing to the way in which the feathers grow round them. These are called *face disks* and are usually white.

3. We will then note down what we have observed of this bird:—

(*a*) The eyes are large, and appear more so on account of the feathers growing in a ring round them.
(*b*) The upper part of the beak is curved like a sharp hook.
(*c*) The claws (four on each foot) are long, sharp, and curved like hooks.
(*d*) The wings are large, almost covering the tail when folded.
(*e*) From head to tail, the bird measures about 14 inches. (*Sketch a life-size drawing.*)

FOOD.

1. If we compare the owl's beak and claws with those of the hen and duck, we can see at once that they are quite unsuitable for either:—

(*a*) Scratching and picking up small grains, or
(*b*) Swimming and finding food in water or amongst the mud.

2. The fact is, these sharp claws are used just as the cat's are—

Fig. 31. An Owl.

for catching living animals, and the owl lives chiefly on mice and voles. These animals are caught with the sharp claws, and killed and eaten with the hooked beak. Therefore, just as we have compared the owl's claws with the cat's, we may also see a resemblance in the beak to the long tearing teeth of that animal.

3. The owl has no teeth, and so must swallow its prey in pieces, fur and bones altogether; but these are afterwards cast up in the form of little balls or pellets, and by examining these pellets we can tell what the owl has been eating.

Many people are under the impression that owls are farmers' foes, because it is thought that they eat eggs and young chickens; but instead of this being true they are really farmers' friends, for they kill the mice and rats that would, if left to increase, eat both eggs and chickens. There need be no doubt of this; we have only to examine the pellets cast out by the birds.

HABITS AND ADAPTATION.

1. Now when are mice and rats most likely to be caught? At night. Why? Because they then come out of their holes. Thus we see:—

(*a*) Mice and rats are the prey of owls.
(*b*) These animals are most easily caught at night.
(*c*) Owls must therefore seek their prey by night.
(*d*) To do this they must have eyes suitable for seeing in a dim light.
(*e*) The owl's eyes are therefore large for this purpose.

2. If you see an owl in the daytime, it either keeps its eyes shut or is continually winking. Why do you think this is? The light is too strong for its eyes. We therefore see:—

(*a*) The owl cannot see by day; because
(*b*) Its eyes are formed for seeing in a dim light; *because*
(*c*) Its prey is only to be found when the light is dim.

3. This suggests a further comparison with the cat. The cat's eyes are formed for seeing in a dim light; but how does it manage to see by day also? The pupil can be reduced to so

small a size that very little light can get into the eye; but the owl must close its eyelids to effect the same purpose. The owl then may be called the cat amongst the birds, for :—

(*a*) Both owl and cat feed on prey.
(*b*) Both have sharp claws and a mouth for that purpose.
(*c*) Both have eyes with which they can see best in a dim light when their prey is most likely to be found.

4. The owl therefore generally sleeps by day and hides away in a barn, church steeple, or similar place. There it lays its eggs, and its young are like little balls of wool.

5. If you have a living or stuffed specimen to examine, observe how soft and downy are the owl's feathers—much more so than those of either the hen or duck. We have already noticed the large wings. These large wings enable the bird to fly easily, with a gentle motion, and the soft downy feathers make no noise when they strike against the air, as the hen's and duck's do; thus it can fly down upon its prey without being heard.

SUMMARY.

1. The owl is a bird of prey, and it is formed for the life it leads :—

(*a*) Its claws and beak are sharp and hooked.
(*b*) Its eyes are most useful in a dim light when the prey is to be found.
(*c*) Its feathers enable it to fly noiselessly, so as not to be heard when darting down upon its prey.
(*d*) It is able to cast up the indigestible part of its food.

LESSON XXV.

BIRDS.

Stuffed or living specimens of small birds, birds of prey, swimming birds, &c. Pictures. Drawings of feet and beaks of different kinds as in figures below. Some birds' bones.

WHAT IS A BIRD?

1. In our last three lessons we have spoken of birds without attempting to say what we mean by that term. Now you would not call a cow or a dog a bird, but you would a duck or an owl.

2. Why then is a dog not a bird?

(*a*) It has no feathers.
(*b*) It has no beak.
(*c*) It has no wings.
(*d*) It has four legs.

These are good reasons, and they therefore tell us what we do call a bird, viz., an animal that has feathers, a beak, wings, and two legs.

3. But if we say a bird has wings we need not mention the two legs. Why? What are the wings? The two fore limbs formed for flying instead of walking, so that the bird has only the other two limbs left to walk with.

4. But stay a moment. Have we not learnt something about another animal whose fore limbs were used as wings? The bat. Now is a bat a bird? Consider:—

(*a*) A bat has not feathers but fur.
(*b*) A bat has no beak, but a mouth and teeth.

Then it only resembles a bird in having wings; so we do

Fig. 32. Hooked Bill of Eagle.

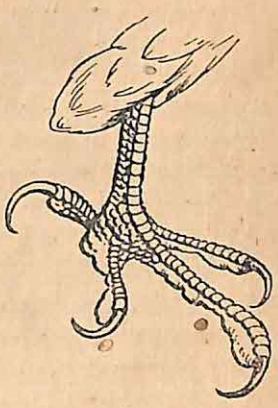


Fig. 33. Foot of Hawk to show talons.

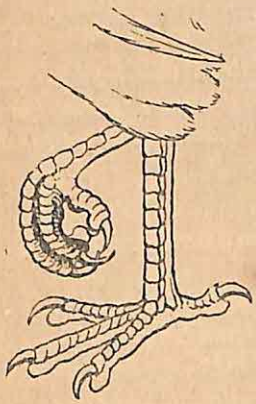


Fig. 34. Legs and Feet of Hen; one bent as in walking to show the action of the toes.

not call a bat a bird, but in saying what a bird is, we must leave out the wings. We therefore know a bird by its having:—

(*a*) A beak, and
(*b*) Feathers.

BIRDS AND MAMMALS.

1. Why are such birds as hens and ducks often kept by people? On account of their uses:—

(*a*) Their flesh is eaten.
(*b*) Their feathers are used for making beds.
(*c*) Their eggs are used for food.

2. But all eggs are not used for food; on some the hen (or duck) is allowed to sit until young ones come out of them. Have you ever seen the mother hen feed her young chickens? She gives them small grains which they are able to peck with their tiny beaks soon after they have come out of the shell.

3. Now this is not the way the mother dog feeds her little puppies. She has milk for them to suck just as the cat has for her kittens, the cow for her calf, the sheep for her lamb, and the bat for her young ones. So we see:—

(*a*) Birds lay eggs.
(*b*) Birds have no milk for their young.
(*c*) Cows, dogs, cats, sheep, &c., have milk for their young.

So just as we give the name bird to those animals having a beak and feathers, we have a name for those animals that have neither beak nor feathers, but *give suck to their young*. We call them *mammals*.*

KINDS OF BIRDS.

1. All birds we have seen are not alike. They have different kinds of beaks:—

(*a*) The hen has a beak for pecking.
(*b*) The duck has a beak for spooning up out of mud and water.
(*c*) The owl has a hooked beak for tearing prey.

2. And just as these birds have these different beaks to eat

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* There are a few exceptions, such as the duck-bill.

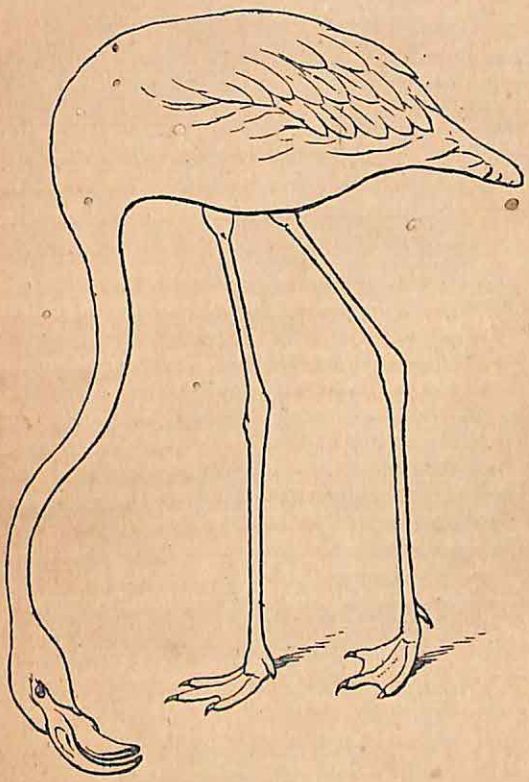

Fig. 35. Flamingo.

different kinds of food, so they have different kinds of feet and claws to help them to get their food:—

(*a*) The hen's toes are formed for scratching to find grain.
(*b*) The duck's for swimming and paddling.
(*c*) The owl's for seizing living animals and holding them fast.

3. Thus there are three kinds:—

(*a*) Scratchers.
(*b*) Swimmers.
(*c*) Seizers.

4. Examples of these kinds may be cited, and the beak of the eagle and foot of the hawk, as shown in Figs. 32 and 33, noticed. These show us to which class the two birds belong.

5. Observe:—

(*a*) The large wings of the swallow which enable the bird to keep continually on the wing in order to meet with insects that fly in the air.
(*b*) The long bill and long tongue of the woodpecker with which it extracts worms from the trunks of trees.
(*c*) The long legs and long neck of the flamingo (Fig. 35). It can walk in deep water; its bill is suited for burrowing in sand, and its feet for swimming. It lives in S. Europe and Africa.
(*d*) The long legs of the ostrich. These are well-formed for running, but the wings are too small for flying.
(*e*) The short hard bills of seed-eating birds; bullfinch, chaffinch, &c. The grain-eating birds have gizzards.
(*f*) The bones of birds are hollow, and therefore light.

PERCHING.

1. Many birds prefer to rest and sleep on branches of trees or rails. This is called perching. But how does a hen, for instance, keep on the perch when asleep? If you have noticed a hen's foot when lifted up in walking, you will have seen that the toes are always drawn in when off the ground (Fig. 34). In fact, whenever the leg is bent the toes are drawn close. When therefore the bird sits down on the perch the toes are made to clasp the perch, and they cannot easily be unclasped without lifting the bird.

LESSON XXVI.

AN EGG.

A new-laid egg, a hard-boiled egg; an egg containing a chicken ready to leave the shell (with half the shell broken away) preserved in spirit.

PARTS OF AN EGG.

1. Here are two hen's eggs; one has been boiled, but outside they look alike. Notice their shape and colour :—

(*a*) The eggs are white.
(*b*) They are longer than broad.
(*c*) One end is broader than the other.
(*d*) The narrow end is pointed.
(*e*) This shape is called oval.

2. Break the boiled egg and observe the parts :—

(*a*) The egg is covered by a hard shell
(*b*) Inside the shell is a white mass.
(*c*) In the middle of the white is a ball of yellow stuff.
(*d*) This yellow stuff is called the yolk.

3. Carefully crack the shell of the other egg and chip it away, bit by bit, so as to expose the skin which lines the shell. Then cut the skin and allow its contents to glide out into a saucer or beaker; observe :—

(*a*) The shell is lined by a thin, rather tough skin.
(*b*) The yolk floats in the white.
(*c*) The "white" is almost colourless when not boiled.
(*d*) It is liquid and sticky like gum.
(*e*) The yolk is enclosed in a very thin skin or membrane.

INCUBATION.

1. Now eggs are not always eaten; they are often kept for another purpose—to produce chickens. And what has to be done to them? The mother hen sits on the eggs till chickens come out of them. Yes, and there is another way. Sometimes eggs are placed in a kind of box, which is kept warm by having a vessel of hot water continually under it, and if the right heat is kept up, the chickens may be hatched just the same. The proper heat (or temperature) is that of the hen's body, about 108° Fah. This heat must be kept up for three weeks. So we see:—

(*a*) Chickens are hatched from eggs.
(*b*) For this purpose, heat is necessary.
(*c*) The eggs must be kept warm for 21 days.

DEVELOPMENT OF THE CHICK.

1. Here now is an egg which has been kept at the proper temperature for three weeks, and the chick was just ready to leave the shell. Observe:—

(*a*) The chick entirely fills the shell.
(*b*) There is nothing in the shell but the chicken.
(*c*) The whole white and yolk have become chicken.

2. Let us now look again at the unboiled egg; something will be seen like tangled threads on each side of the yolk; these are called *balancers*. On the upper side of the yolk is a pale yellow spot; this is that which would grow to be the chicken.

3. When in the egg, the yolk always floats in the middle, and the yellow spot is uppermost; if the egg is turned over, the balancers enable the yolk to regain its position slowly, so that the chick, even if it has begun to grow, is not injured. And it is very necessary that eggs should be turned. When a hen sits on eggs she often turns them with her beak, and if they are not turned, the chickens, though they may be hatched, generally die. The eggs should also be allowed to cool a little daily, but not to become cold.

4. Considering then the parts of the egg and what becomes of them, we see:—

(*a*) An egg consists of seven parts—shell, membrane, white, yolk, yolk bag, balancers, and pale yellow spot in the yolk.
(*b*) The pale yellow spot grows to be the chicken.
(*c*) The chicken as it grows feeds on the white and the yolk.

LEAVING THE SHELL.

1. Now how does the chicken get out of the shell? Notice its position :—

(*a*) The chicken lies in the shell with its head towards the broad end.
(*b*) Its head is curved round towards its side.

2. When strong enough, and grown as large as possible in the shell, the chicken begins to peck at the inside of the shell. In doing so, it breaks the thin membrane that surrounds it, and gets air to breathe. Observe that the shell is porous. Then it pecks harder, and breaks a bit of the shell. This done, it widens the hole to get out its beak; then it moves its limbs, breaks the shell into two or more pieces, and finds itself free. It is covered with down which is still wet. Soon, however, it is dry, and then it begins to run about and pick up small bits of food.

USES OF EGGS.

1. The great and first use or purpose of eggs is to produce young.
2. Eggs are excellent food and are eaten in many ways.
3. The shell protects the soft contents from being injured.

LESSON XXVII.

EGGS AND NESTS.

Two or three nests of different kinds, such as the thrush's, swallow's, chaffinch's, sparrow's, skylark's; eggs of the same or other birds; guillemot's egg, hen's egg.

FORMS OF NESTS.

1. All birds, we have said, lay eggs. These are placed in nests until there is a sufficient number to sit upon; then the bird sits close to keep up the necessary heat in order to hatch them. Many birds only need to sit on their eggs fourteen days.

2. Here are some nests that have been made by birds. Observe with what care they have been fitted together. Take first the thrush's nest and notice :—

(*a*) The outside of the nest is made of dried grass.
(*b*) The inside is carefully lined with an even layer of mud worked to a smooth surface.
(*c*) The eggs are five in number, and blue with a few black spots.

3. Now here is a chaffinch's nest; notice :—

(*a*) It is made chiefly of moss, dried grass, and thin roots or stalks.
(*b*) It is lined with horsehair and a few feathers.
(*c*) The whole mass is beautifully *felted* together.
(*d*) The five eggs are of a dull bluish green and dull red.

4. Observe the structure of other nests :—

(*a*) The swallow's nest is made of mud and lined with feathers.
(*b*) The house-sparrow builds its nest of all kinds of odds and ends.

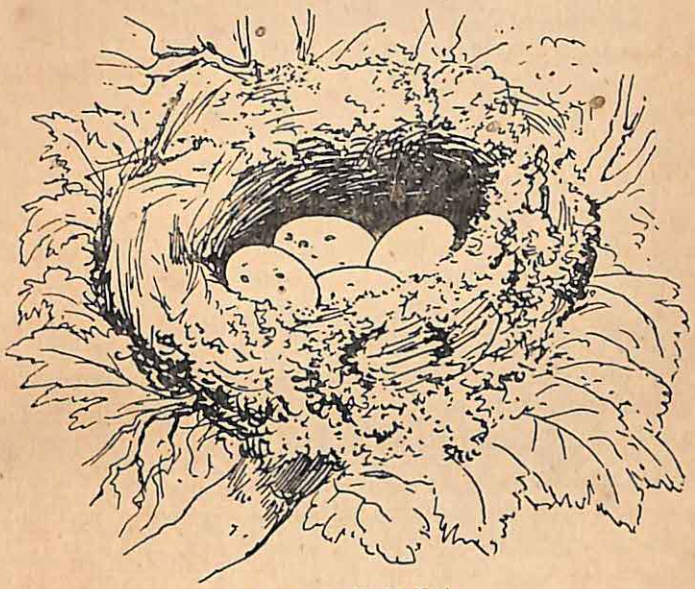

Fig. 36. Chaffinch's Nest.

"Not neatly wove with decent care
Of shining moss and silvery hair,
But put together, odds and ends,
Picked up from enemies and friends."

(*c*) The rook's nest is made up of sticks.

5. Some nests show great pains have been taken, and some, like the water hen's, that very little trouble has been spent on them.

PLACES OF NESTS.

1. One thing is very clear, and that is, that all these different nests are not made to occupy the same kind of place :—

(*a*) The thrush builds in a bush.
(*b*) The chaffinch builds on the side of a tree trunk.
(*c*) The swallow builds against a wall.
(*d*) The rook's nest is a kind of rough basket placed near the top of a tall tree.

2. These nests are all placed either :—

(*a*) Where they cannot easily be reached, or
(*b*) Where they cannot easily be seen.

The chaffinch's nest often looks just like a part of the trunk of the tree in which it is built.

COLOURS OF EGGS.

1. Just as there is a reason for the different shapes and places of nests, there must be also a reason for the different colours of birds' eggs. Birds have many foes that would steal their eggs,—weasels, stoats, and even other members of their own class, like the jay and the magpie.

2. White eggs are most easily recognized ; therefore if the various colours of eggs help to make these foes think they are not eggs, then the colour must be a means of protection. The skylark builds on the ground, and both its nest and eggs are brown like the soil. If its eggs were white they would much more easily be seen.

3. Birds that lay white eggs have little to fear, or else they cover them whenever they leave the nest.

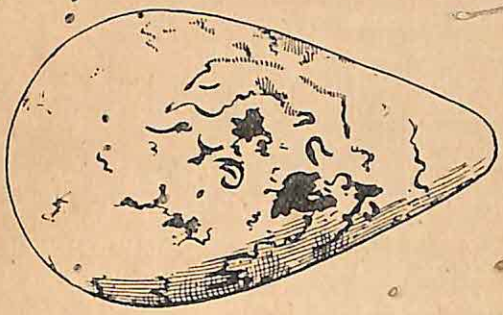

Fig. 37. Guillemot's Egg.

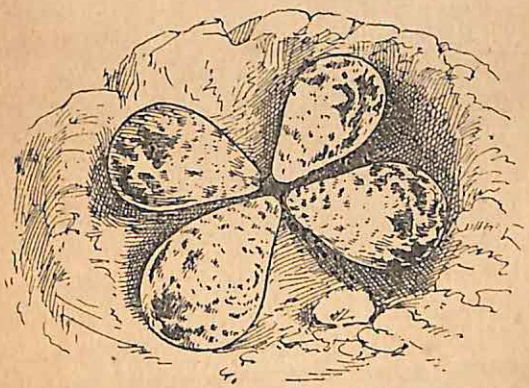

Fig. 38. Dunlin's Nest to show shape and position of eggs in a nest of slight structure.

SHAPES OF EGGS.

1. We have noticed the shape of the hen's egg. Why should every hen's egg be of this shape? Consider the shape of the nest. Make a drawing to represent the plan of a nest—a circle—with eggs lying in it; place them with their points towards the centre, and it will at once be obvious that more eggs can be contained, and that they fit together better than they would if they were of some other shape.

2. Now roll an egg along the table; it does not travel like a ball, but turns round towards a centre to which the sharp end points. Hens sometimes lay eggs on little more than the bare ground. If they were like balls what might happen to them? They might easily roll away.

3. Notice the guillemot's egg; it is much more pointed than a hen's. The guillemot is a seabird, and lays its eggs on the bare rocks by the sea in places that must be much exposed to the wind. If the eggs could be rolled along they would soon be blown out of the nest. Fig. 38 shows a nest of the dunlin. We therefore see:—

(*a*) The pointed shape best fits a round nest.

(*b*) The pointed egg can only roll in a circle and therefore cannot easily be blown or knocked out of the nest.

SUMMARY.

1. Birds' nests are fixed in various places to be safe from foes, and when not out of reach their shape and colour often help to hide them.

2. Birds' eggs are coloured in such a way as to make them recognizable with difficulty by egg-eating animals.

3. The shape of many birds' eggs is the best one for preventing them from being blown or knocked out of the nest

OBS. 1. A hen does not mind if her eggs are removed so long as one is left, even if it be an earthenware one; but other birds are jealous of disturbance, and very timid. The taking of an egg, or sometimes the bending of a few twigs, is sufficient to cause a nest to be forsaken.

OBS. 2. Instead of birds being the foes they are sometimes believed to be, they are the friends of the gardener and farmer. They prey on insects

and grubs that would otherwise do great damage to crops, and if there is a danger of small birds becoming too numerous, their numbers will be kept down by the hawks and other birds of prey,—if these are not shot.

Obs. 3. To take birds' nests or to cause them to be forsaken is therefore not only an act of cruelty, but also foolish and injurious. No eggs should be taken; nests may be removed after the flight of the young birds. But quiet, careful observation, without meddling or intrusion, is the only humane way of getting to know our feathered friends.

Obs. 4. Occasionally eggs may be required for scientific purposes; then, and only then, should they be taken by those who know when and how to take, and are capable of appreciating *the limits of such purposes.*

LESSON XXVIII.

A FISH.

A fresh herring; some gold fish or small fish (such as can be caught in a local stream) in a globe or glass jar of water.

A HERRING.

1. Here is a herring. Every child in the class will probably be able to say that it is a fish and has lived in water. Let us see what kind of an animal it is; notice limbs, shape of body, &c.:

(*a*) The herring has no legs, but it has fins for swimming.
(*b*) It has a long narrow body tapering towards each end.
(*c*) It has no neck, but the pointed head is joined to the body.
(*d*) This shape is best suited for cutting through the water, just as an arrow flies through the air more easily than a broad thick piece of wood.
(*e*) The body is covered with scales.

2. What is a bird's body covering? Feathers. Why are these especially useful? They are warm and very light; the air can easily get amongst them and help to keep up the bird when flying. Now why should a fish have scales rather than feathers? First, however, look at these scales, and say what they are like—little bits of thin horny substance; they will protect the herring's body from the water. So then, as the bird has a covering to fit it for living in the air, the herring has one to fit it for living in the water.

3. Notice further the head:—

(*a*) The mouth is large.
(*b*) The eyes are without eyelids; they cannot be tender like ours. They are covered with a transparent horny covering.
(*c*) There are four nostrils.

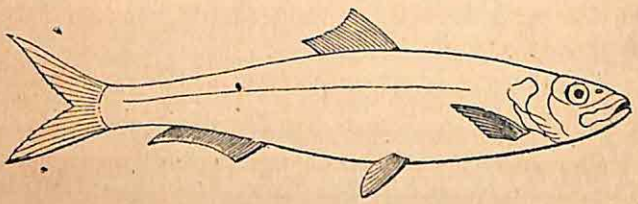

Fig. 39. A Herring.

FINS.

1. Let us look at some living fish and watch them as they swim about in the water. See how the tails move from side to side. Notice the fins at the sides. Perhaps you have seen a man cause a boat to move along on the water by moving an oar from side to side at the stern. This is the way in which the fish moves its body along, aided of course by the other fins. How many fins has the herring, and where are they placed?

(*a*) Two tail fins.
(*b*) One back fin.
(*c*) One fin under its body and towards the tail.
(*d*) Two pairs of side fins—eight fins in all.

2. These pairs of side fins take the place of limbs; they are all the fish has to stand for legs and arms. But legs and arms it can do without, for it swims instead of walking, and it uses its mouth for taking its food.

GILLS AND RESPIRATION.

1. If we went into water we should not be able to stay below the surface for many seconds together; why? We should want air. Now observe these little fish in the water:—

(*a*) Fish stay under water for a long time, and only come to the surface for food.
(*b*) Therefore they cannot breathe air as we do.
(*c*) But all the time they keep on opening and shutting their mouths as though they were drinking water.

2. They are not exactly *drinking*, but they are taking water into their mouths. Look now at the sides of the herring's head just behind the eyes. There are openings or slits, the sides of which are very red; these are called the *gills*. Pass a thin stick through; it comes out at the mouth. There is therefore a passage from the mouth through the gills; and the water taken into the mouth passes out again through them.

3. It will perhaps be known that when we breathe, although we take in pure air, yet when that air is breathed out again it is no longer pure, but contains a poisonous gas called carbon-di-

oxide. The removal of this gas from our lungs purifies our blood. This is the purpose for which we breathe. For the same reason a fish breathes water. The water contains a little air, and this purifies its blood as it passes through the gills; for a fish has no lungs. We have noticed the redness of the gills; this is caused by the blood being near to the surface, so that the air can easily come in contact with it. The blood does not mix with the water, but it is separated from it only by a very thin skin.

4. We therefore see that a herring (or other fish) is especially fitted for living in water :—

(*a*) By the shape and covering of its body.
(*b*) By its fins for swimming.
(*c*) By being able to breathe water instead of air.

5. A fish is sometimes called cold-blooded. This only means that its blood is not so warm as that of mammals or birds. The small amount of air it gets could not keep up a temperature as high as theirs.

REPRODUCTION.

1. Herrings lay eggs, very small, but in great numbers. You have no doubt seen what is called the hard roe. These are unlaid eggs.

What these eggs are like we shall better see in the next lesson.

NOTE.—*Other fish, like the plaice, might well be compared with the above, and form the subject of another lesson.*

LESSON XXIX.

THE FROG.

A live frog; some frog spawn in water; some tadpoles in water; drawings on black-board.

If this lesson is not taken in the spring, it should be divided, and "Tadpoles" should be the subject of another lesson at a suitable time. Or, tadpoles in different stages of development may be kept from the previous season by being preserved in methylated spirit. It is best, however, that children should see the eggs and the living tadpoles hatched from them.

HABITS AND APPEARANCE.

1. Everybody knows one thing a frog can do. It can leap a long distance. Here is one on a slate on the table. See how far it can jump, and how difficult it is to catch it again.

2. Why is it so difficult to catch the frog? Because its skin is smooth, wet, and slippery. Try to hold this one. Be careful not to hurt it. It has to be squeezed rather tightly or it would slip through the fingers.

3. If you wanted to find a frog, in what kind of place would you look? Amongst deep grass, near water, or in ditches. These are the places in which the frog passes most of its time, but occasionally one may be seen hopping across the road just at dusk in the evening.

4. In winter frogs are not seen, for they go to sleep in holes in banks or sheltered places. Why? Well, we have seen that some other animals do the same because they would not be able to find food in the winter. What do those animals feed on?

Some, like the hedgehog, on insects. Insects, too, form the food of the frog, and because none are to be found in winter he then goes to sleep.

DESCRIPTION.

1. Let us now examine our frog. (The following points will readily be observed if brought out by a few judicious questions) :

(*a*) The frog is of a yellowish green colour, with pale yellow underneath.
(*b*) It has four legs; the hind ones are longer than the fore.
(*c*) It has no tail.
(*d*) There are *four* toes (or fingers) on each fore foot.
(*e*) Each hind foot has *five* much longer toes.
(*f*) The first toe in the place of the human great toe is the shortest, and the third the longest.
(*g*) The hind toes are joined by a skin or web.

2. Now what can be the use of these webbed feet? Have you ever seen a frog swim? Frogs often go into the water; they will swim to the bottom of a pool or well by the aid of these webbed feet, which they use in the same way that a duck uses its feet.

3. A frog cannot, however, remain long in the water like a fish. Why? A fish can breathe water, but a frog breathes air. How do you know this? A fish can only live in water, but a frog lives most of its time out of water.

4. Look now at the frog's head :—

(*a*) The head is broad and flat.
(*b*) The eyes are large and stand out at the sides.
(*c*) The mouth is large.
(*d*) There are two nostrils just above the tip of the upper jaw.
(*e*) There are no ears. (There are hearing-places just behind the eyes.)

5. It is not easy to open a frog's mouth, and we must not be cruel in our desire to get knowledge. If we could see into the mouth, we should find no teeth, but a most peculiar tongue. This tongue is attached where ours is loose, and loose at the

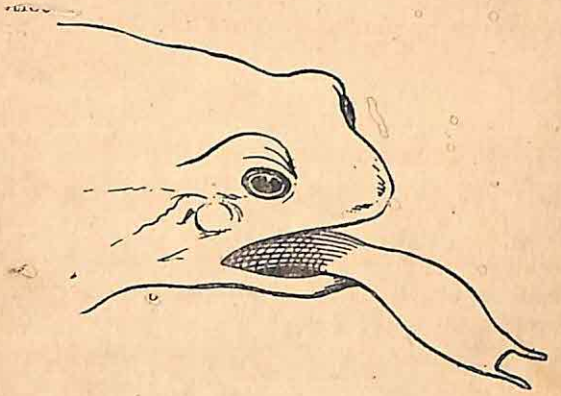

Fig. 40. Frog's Tongue, as in the act of catching an insect.

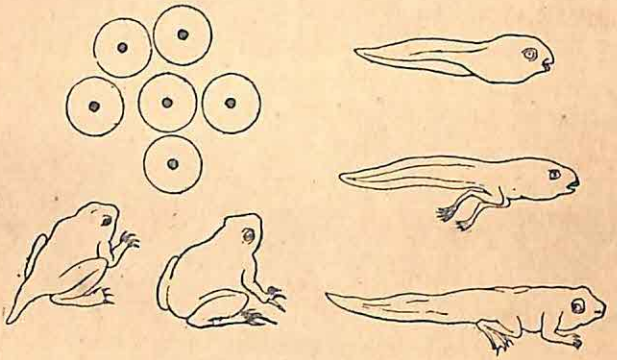

Fig. 41. Tadpole; from the egg to the frog.

other end, so that it can be thrown out to catch a fly, wasp, or other insect.

TADPOLES.

1. Look at these peculiar creatures in this jar of water. Notice :—

(*a*) They seem to be nothing but head and tail.
(*b*) They swim about without coming to the surface (like fish).
(*c*) They swim by moving their tails (like fish).

2. Now these tadpoles, as they are called, have been hatched from eggs laid by a frog. Often in spring you may see masses of jelly floating on the surfaces of pools of standing water or in quiet streams. This jelly is called frog spawn. If you have a specimen, notice :—

(*a*) Frog spawn consists of numerous round bodies like large peas. (Each is an egg.)
(*b*) Each egg is like a mass of transparent jelly, with a black spot in the centre.

3. The black spot is the egg, and the jelly is to it what the shell is to a bird's egg.

DEVELOPMENT.

1. The eggs are laid in the water and sink to the bottom ; but soon they rise and float on the surface. Compare them with a hen's egg :—

(*a*) They are very small.
(*b*) They have jelly instead of shell. Why ?
(*c*) They are laid in water, and have not to be protected from being trodden on.

2. Try to pick one up, and you will see another use of the jelly-like covering.

3. The frog does not sit on them, but by the heat of the sun they are hatched, and tiny tadpoles come from them. These first hold on to blades of grass or leaves in the water, but soon they begin to swim about and eat bits of the water plants.

4. Perhaps, in some, you will see small projecting fringes on each side of the head. These are gills ; for the tadpole has no

lungs. Soon these disappear, as gills like those of a fish take their place, and for a time the tadpole is like a fish. In what respects is this so?

(*a*) It has no limbs.
(*b*) It swims by a tail movement.
(*c*) It lives under water, and purifies its blood by breathing water through its gills.

5. Then legs begin to grow (see Fig. 41), first the hind legs and afterwards the fore ones. At last the tail disappears. It does not fall off, but it gradually shrinks, or is absorbed.

6. While this is going on, lungs are forming and when these are grown, the tadpole becomes a frog, hops out on to land, and lives the life of a frog. Now he must breathe air; his gills disappear, and he can no longer live in water.

7. Many tadpoles get eaten by creatures ready to prey on them; so you may see why a frog lays such a large number of eggs.

8. Frogs are not always yellow. Those that live in muddy ditches or water are often very dark in colour.

SUMMARY.

1. Frogs live in damp or wet places, and have a skin suited to such a life.
2. They have the hind toes webbed for swimming.
3. The tongue is made for catching insects, on which they live.
4. Frogs go to sleep in winter.
5. The frog lays its eggs in water.
6. From the eggs tadpoles are hatched.
7. Tadpoles are like fish in their form and way of living.
8. Tadpoles become frogs and live on land.

THE TOAD.

The toad passes through exactly the same kind of life as a frog, being a tadpole first, but it differs in (*a*) its colour, (*b*) the

dryness of its skin, and (*c*) its manner of moving about, generally crawling instead of leaping.

THE NEWT.

This pretty little creature might well form the subject of another lesson. Newts are amphibians, like the frog, though they spend most of their time in the water, coming to the surface now and then for air. They are quite harmless, and may easily be kept in an aquarium.

LESSON XXX.

REPTILES.

This lesson is inserted with the expectation that one of the types may be treated in fuller detail, according to the possibility of obtaining specimens. Snake preserved in alcohol; skin or skeleton; lizard; crocodile's egg; tortoise, or the "shell" of one; piece of tortoise-shell.

A SNAKE.

1. Snakes are not common in England. When found, it is generally among long grass or on sunny banks. The viper or adder is the only poisonous one, and it is not deadly.

2. From a specimen of this snake, the following facts may be observed:—

(*a*) A snake has a long whip-like body.
(*b*) It has no limbs.
(*c*) Its skin is scaly, and it has a zigzag line running down its back.
(*d*) Its head is broad and flat, and its mouth large; on the top of the head is a V-shaped mark.
(*e*) Its tongue is forked.
(*f*) Its teeth are turned backwards.

3. The poison glands lie at the back of these teeth, and the venom passes through them into the wound. Non-poisonous snakes have solid teeth. Snakes swallow their prey whole. All live on animals of some kind, and many are fond of birds' eggs.

4. How is a snake compensated for its lack of limbs?

(*a*) By its great length and thinness of body.
(*b*) By its power to coil its body round objects, and to squeeze with great pressure.
(*c*) By its power to raise up its body.

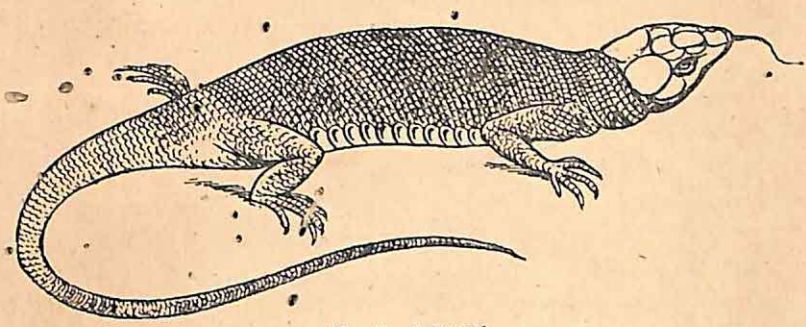

Fig. 42. A Lizard.

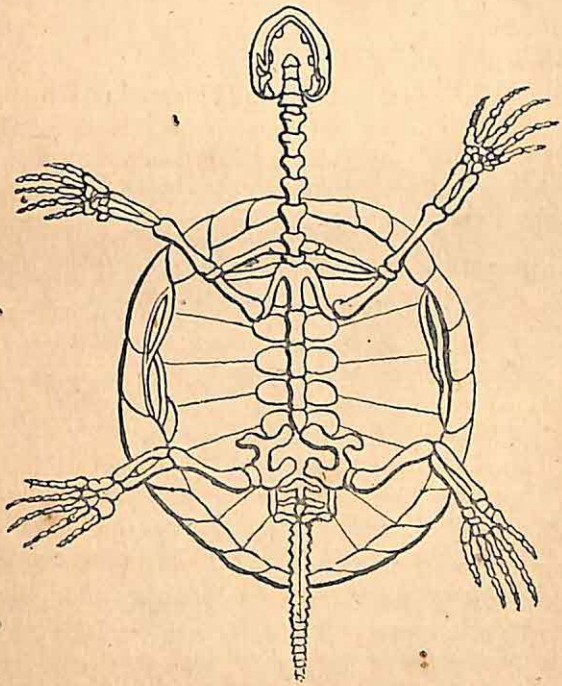

Fig. 43. Skeleton of Tortoise, to show that the carapace is developed from the ribs.

(*d*) By its power to contract or shorten its body so as to be able to push the fore part forward.
(*e*) By its tongue and fangs.

5. Most snakes lay eggs, but the young of the adder are born alive.

A LIZARD.

1. A lizard looks like a very small crocodile, of which most children have seen pictures. Notice :—

(*a*) A lizard has distinctly a head, body, and tail.
(*b*) It has four limbs.
(*c*) On each foot are five sharp-clawed toes.
(*d*) The legs are short and the body rests on the ground.
(*e*) The head is snake-like and the skin scaly. (As in the snake, the scales are due to wrinkling.)

2. A lizard also bears some resemblance to a newt, but it is never a tadpole as a newt is when first hatched from the egg. The newt's tail, too, is flat for swimming, but the lizard's is not.

3. Lizards are found in England, but not crocodiles. While the lizards of our country are not more than a few inches (four to six) in length, crocodiles reach as much as 15 feet. Both these animals lay eggs, which are hatched by the sun.

A TORTOISE.

1. This animal is not found in our country except as a domestic pet, often kept, like the hedgehog, for the purpose of eating beetles and other insects. From a specimen observe :—

(*a*) A tortoise has head, body, and a short tail.
(*b*) The body is covered above and below with a hard bony covering (sometimes called the "shell," but more correctly the *carapace* above and the *plastron* or breast-plate below).
(*c*) The limbs are very much like those of the lizard.
(*d*) The head is snake-like, but pointed almost to a beak.

2. The carapace consists of a number of plates grown together. Each plate is a rib or part of the backbone broadened out. The tortoise-shell of commerce is obtained from the carapace of the hawk's-bill turtle.

3. Turtles are like tortoises, but have their limbs formed as flippers for swimming. Both lay eggs with hard shells.

REPTILES.

1. All these animals are known as *reptiles*.

2. Like frogs and fishes :—

(*a*) They are cold-blooded (about 70°).

(*b*) They lay eggs, and do not provide milk for their young.

(*c*) They have bones.

3. They breathe through lungs like frogs, and unlike fishes.

4. When hatched from the egg they pass through no tadpole stage, and are therefore unlike frogs in this respect.

5. The relation of frogs, fishes, and reptiles is best represented by saying that a frog comes between the two : in early life it resembles a fish, in later life a reptile.

LESSON XXXI.

THE SILKWORM.

Pieces of silk, calico, linen, and cloth; a cocoon; some live silk-worms (or caterpillars); a chrysalis, and, if possible, moth and eggs.

SILK.

1. Here is a piece of silk; compare it with calico, linen, and cloth. Separate the threads of which it is woven, and again separate these into finer threads. (*Children should do this for themselves.*) Observe:—

(*a*) Silk is very soft and smooth.
(*b*) It is softer and smoother than cloth, calico, or linen.
(*c*) It can be crushed up into a very small space.
(*d*) The threads of silk are exceedingly fine.
(*e*) Silk is very strong.

THE SILKWORM.—DESCRIPTION.

1. Now, strange as it may seem, we have here the little creatures from which we obtain silk. (*Produce specimens.*) All the silk in the world is made by such as these. They are called *silk-worms.*

2. Let us look at them. What are they like? Notice carefully all their parts as follows:—

(*a*) Silkworms look like large caterpillars.
(*b*) They are of a dull grey colour.
(*c*) They eat leaves (lettuce), and crawl about on short legs or feet.

3. Notice the body is made up of parts, or seems to be divided by rings. These parts are called *segments.* Count the segments, and then the legs. On which segments do the legs grow?

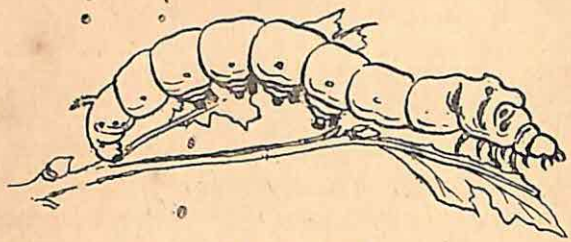

Fig. 44. Silkworm.

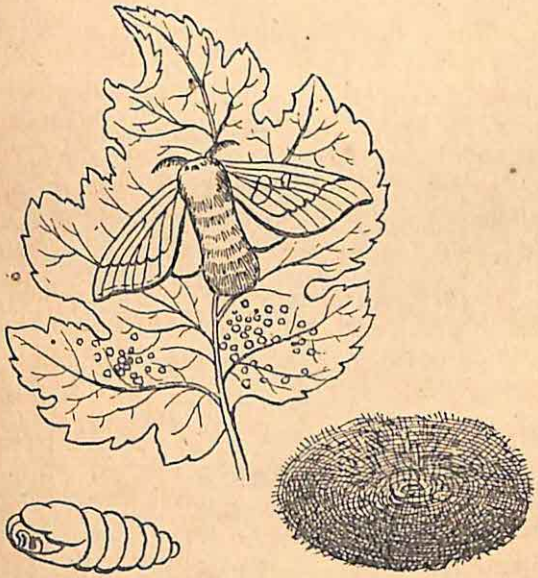

Fig. 45. Silkworm: cocoon, pupa, moth, and eggs.

(*a*) The silkworm's body is made up of *thirteen* segments.
(*b*) The silkworm has sixteen legs.
(*c*) These legs are in groups, *six* in one, *eight* in another, and *two* on the last segment.
(*d*) The first segment forms the head.
(*e*) On the next three are three pairs of legs—one pair on each.

GROWTH.

1. The silkworm eats very greedily, and grows so fast that his skin bursts; but before this happens another one has been forming underneath, so that he can come out of his old clothes with a new suit ready made, and capable of allowing him to go on growing bigger.

2. After two or three changes of skin, the silkworm seems to have grown as much as he can, for he ceases to eat, he hides in a corner, and begins to spin some fine threads about him.

MAKING THE SILK.

1. These fine threads come out of the silkworm's mouth; they are a fine gum at first, but harden on exposure to the air. Soon there is so much fine thread about him that he can scarcely be seen; finally he is lost sight of altogether; only a ball of yellow silk remains. This ball is known as a cocoon.

2. Notice how delicate the threads are. This fine thread must be unwound, and wound up on a reel. To do this, the cocoons are generally thrown into hot water, and then the silk is wound off. When this has been done, it is ready for spinning into stronger threads.

LIFE HISTORY.

1. Now there are two questions that we must try to answer:
   (*a*) What has become of the silkworm?
   (*b*) Why does it spin the silk?

2. Let us cut open a cocoon; what do you notice?
   (*a*) The cocoon contains a small brown pointed thing.
   (*b*) The silkworm has become very small.
   (*c*) This small brown thing has no legs and no mouth.
   (*d*) It moves a little when touched, but it cannot crawl.

(*c*) It shows rings or segments, but thirteen cannot be counted as in the silkworm.

3. This brown object is generally called a chrysalis, but *pupa* is a better name; it is a word which means a bundled-up baby, and that is what the thing is like.

4. If we keep this pupa for a few weeks (or perhaps months) another remarkable change will take place; the brown skin will burst, and out of it will come a *moth*. (*If one is at hand it should be seen.*) The moth flies about, lays a great number of tiny eggs (*show some*) and then dies. The sun hatches the eggs; from them come little tiny silkworms, and the same course is gone through again.

5. But why did the silkworm spin the silk? It is evident that in the cocoon the silkworm changed from being like a caterpillar to a pupa, and that in the pupa state, further important changes must have taken place.

Imagine now the silkworm, living as it does in other countries like France, Italy, and China, on trees, but suppose it did not spin silk, what might happen to it when in the pupa state? It would probably be eaten by a bird. What then is the silk for? A protection.

SUMMARY.

1. Silk is obtained from the cocoon of the silkworm.
2. The stages in the life of this creature are:—
   (*a*) Egg.
   (*b*) Caterpillar (or silkworm).
   (*c*) Pupa protected by cocoon of silk.
   (*d*) Moth with wings.

LESSON XXXII.

BUTTERFLIES AND MOTHS.

A few mounted butterflies and moths should be ready for this lesson. When caught they should be killed by being dropped into a jar prepared for the purpose; or a small jar containing a little blotting paper soaked in benzine will do. As soon as dead they should be set by being pinned through the body to a cork pad and their wings spread by narrow strips of thin cardboard pinned to hold them down. When set they should be mounted on small cork pads, one on each, so that they can be handed round the class.

INTRODUCTION.

1. In the last lesson we saw that a silkworm finally became a moth. Children will have often seen moths and other creatures very much like moths, and will know when and where such are seen. They may be able to name some:—

(*a*) Moths often fly about at night.
(*b*) They are attracted by a light and sometimes get their wings singed by approaching too near to a flame.
(*c*) Butterflies look like moths.
(*d*) They fly about in the sunshine and alight on flowers.
(*e*) The white cabbage butterfly is a common kind.
(*f*) The little clothes-moth is also common.

2. In this lesson we are going to try to learn something about these pretty creatures, of which there are many kinds, and the silkworm moth is only one of them.

LIKENESSES.

1. Here now is a butterfly on this card, and here, too, we have a moth (Figs. 46 and 47). Let us see, first, in what

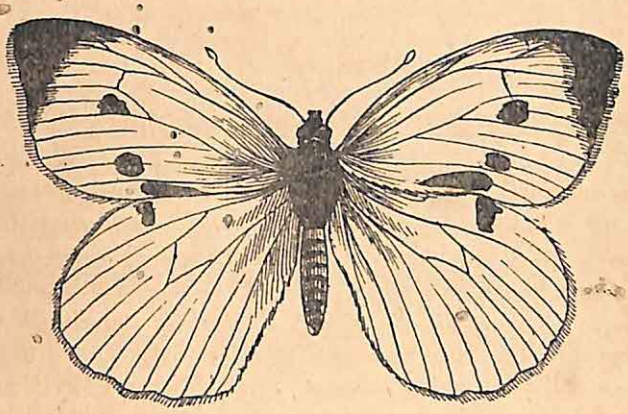

Fig. 46. Large White Cabbage Butterfly.

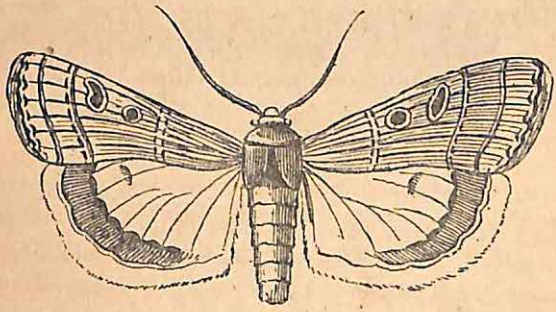

Fig. 47. Moth—Yellow Underwing.

respects they are alike (*Sketch large drawings side by side as points are observed*) :—

(*a*) Wings—the butterfly has four, the moth has four.
(*b*) Legs—the butterfly has six, the moth has six.
(*c*) Horns—the butterfly has two, the moth has two.
(*d*) The wings of both are covered with a dust which easily comes off when touched.

2. If this dust can be seen under a magnifying glass or microscope, it will be found to consist of numerous little *feather-like* scales which overlap each other like the tiles on a roof. The removal of the scales destroys the beautiful pattern of the wings.

3. Examine the body; in each case it consists of three parts :—

(*a*) The *head*, carrying the horns.
(*b*) The *chest* (or thorax), carrying the legs below and the wings above.
(*c*) The *abdomen*, having nothing attached to it, but made up of rings or segments.

DIFFERENCES.

1. In observing these points of resemblance several differences must have been seen. We will now turn our attention to them :—

(*a*) The butterfly has a slender body, but the moth a thick one.
(*b*) The butterfly's under wings are as large as its upper wings.
(*c*) The moth's under wings are shorter than its upper wings.
(*d*) The horns of the butterfly have knobs at the end.
(*e*) The moth's horns are not knobbed.
(*f*) When resting, the butterfly turns its wings upwards.

2. All these distinctions may generally be observed, but they are not all equally well seen nor of equal importance; for instance, in some moths the body is quite as slender as in some butterflies. The difference in the form of the horns is the most important, the butterfly's always being knobbed. It may be mentioned that what we have called horns are known as *antennæ*, each one being spoken of as an *antenna*. What is the

use of them is not quite certain, but if a moth or butterfly has its antennæ injured it cannot fly.

FOOD.

1. What do butterflies eat? Watch them on a summer's day as they flit from flower to flower. Look at the specimen before you; on the fore part of the head you will find something rolled up like a watch spring. With a needle uncoil it, and you will find it a long trunk-like thing growing from the front of the creature's head. The same may be found in the moth.

2. If a butterfly has been watched alighting on flowers, it will have been noticed that this long trunk is used to be inserted in tube-shaped flowers. It is, in fact, a trunk with which its owner sucks up a honey-like liquid out of flowers, for the butterfly and moth have no jaws or mouth, but must get all their food in a liquid form.

EGGS.

1. Besides seeking honey these pretty creatures have another object in flitting about amongst the plants. The white butterfly will have been seen amongst the cabbages of the garden, although they have neither flowers nor honey. It is seeking a place in which to lay its eggs, not a place where honey abounds, but on cabbage-leaves. So also other kinds as well as moths may be seen on other plants. The consideration as to why they do this we must leave for the next lesson.

2. We will close this lesson by mentioning a few kinds of butterflies and moths:—

(*a*) Butterflies—

White Cabbage (very common).
Red Admiral (often called French by children).
Common Blue.

(*b*) Moths—

Yellow Underwing (see Fig. 47).
Hawk Moth (very large, several kinds).
Clothes Moth (very small).

Note.—Children should be encouraged to observe the habits of butterflies and moths, but not to catch them. It may be necessary to have a few caught for close inspection, but it is to be earnestly hoped the mere making of collections like those of coins and postage stamps, will be in every way discouraged. Collections, unless made with enlightenment, have no scientific value, and only tend to lead to the destruction of rare species, and to warp the moral sense of the collector.

LESSON XXXIII.

CATERPILLARS.

Specimens of different kinds of caterpillars, moth's or butterfly's eggs, pupæ, and, if possible, the butterfly or moth developed from such caterpillars as the specimens present. Drawing of caterpillar.

SOME KINDS OF CATERPILLARS.

1. Show children several different kinds of caterpillars and note the plants on which they were found. If children have brought them they should be called upon to name the plants as far as they can. It may be observed :—

(*a*) Some caterpillars are green and naked.
(*b*) Some are brown and naked.
(*c*) Some are hairy and variously coloured.

2. But all will be found to agree in certain points :—

(*a*) They are long and thin.
(*b*) They creep slowly.
(*c*) Their legs are very short.
(*d*) They have each 16 legs (6 and 10).*
(*e*) Their bodies are composed of parts or segments—13 in number.
(*f*) In all these respects they are like the silkworm.

WHAT ARE CATERPILLARS?

1. Now here are some strange-looking bodies; what can be observed of them?

(*a*) They are brown, and pointed at one end.
(*b*) They have no legs.

---

* Not invariably; the ten are sometimes reduced to a smaller number.

(*c*) They seem dead, but move slightly when touched.
(*d*) They are like the pupa of the silkworm.

2. These have been obtained from caterpillars. Some caterpillars were placed in boxes, leaves were given them to eat and they turned into these forms. Such are often found in the soil of gardens.

3. Here is the brown skin of one empty (*show specimen*). Out of it has come a butterfly, just as out of the silkworm pupa there came a moth.

4. Look now again at some of the pupæ; although you can see no legs you will see something which looks like folded wings. What do we learn?

(*a*) Some caterpillars become pupæ.
(*b*) Out of pupæ butterflies come.

But we have seen that out of a silkworm pupa, a moth appeared; and so, too, we shall find that other moths have once, like butterflies, been caterpillars.

5. We have seen in the last lesson that butterflies and moths lay eggs; from these the caterpillars are hatched, and so we see the stages or states through which these creatures pass:—

(*a*) The egg.
(*b*) The caterpillar.
(*c*) The pupa.
(*d*) The full-grown winged creature (butterfly or moth).

FROM CATERPILLAR TO BUTTERFLY.

1. We see, then, what caterpillars are—young butterflies or moths. Now there is one mistake that should be guarded against here. When a butterfly or moth emerges from the pupa covering, it has grown to its full size. A little moth or butterfly never grows into a big one.

2. In which state then does the growing take place? The caterpillar state when the creature eats and grows so much that it has to cast its skin several times. We may then describe the three stages after the egg as follows:—

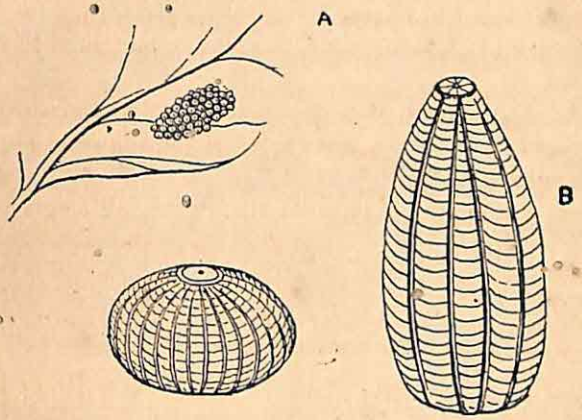

Fig. 48. Butterfly's eggs. A, natural size; B, magnified.

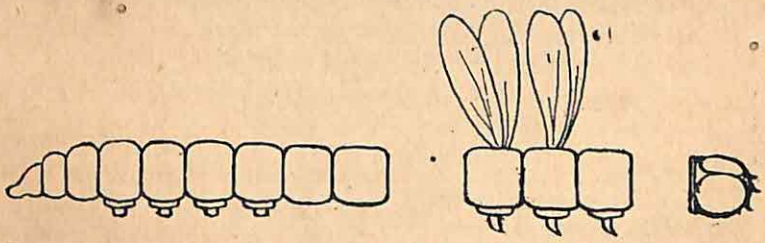

Fig. 49. Diagram of a Caterpillar or Larva to show the relation between that stage and that of the perfect insect.

(*a*) The eating and growing stage.
(*b*) The resting stage when great changes take place.
(*c*) The flying and egg-laying stage.

3. Now what are the great changes that take place in passing from caterpillar to butterfly? Let us compare:—

(*a*) The caterpillar has sixteen legs, the butterfly six.
(*b*) The caterpillar has no wings, the butterfly has four.
(*c*) The caterpillar eats, that is, it has jaws, the butterfly has no jaws, but only a trunk.

4. While the creature is a pupa then, it loses:—

(*a*) Ten legs and its jaws,

but gains:—

(*b*) Four wings, and a trunk.

We can therefore see that it is necessary for the creature to go through such a state as that of being a pupa, for otherwise how could it feed while its jaws were being changed into a trunk?

5. Now the three sections of a moth's or butterfly's body have been noticed:—

(*a*) Head.
(*b*) Thorax.
(*c*) Abdomen.

6. Notice a caterpillar; no such sections appear, but the thirteen segments can be counted. In the butterfly there are distinct traces of these segments, but you cannot count all the thirteen; in some creatures similar to these they can be observed and they are apportioned as follows:—

(*a*) Head—first segment.
(*b*) Thorax—next three.
(*c*) Abdomen—last nine.

PROTECTION. (*This may be made a separate Lesson.*)

1. We noticed at the beginning that some caterpillars were green, some brown, and some hairy, and it will probably have been noticed:—

(*a*) Green caterpillars are found on green leaves.
(*b*) Brown caterpillars on brown stems.
(*c*) Hairy caterpillars in various places.

2. What enemies have caterpillars to fear? Birds. But do you think a bird would swallow a hairy caterpillar? No. What then may be one purpose of its hairiness? To protect it from being eaten by birds.

3. Consider now green caterpillars. Suppose they were to be found on all kinds of plants, green, and brown, on which leaves would they be most likely to escape notice? On the green leaves. Why? Because being of the same colour as the leaves, they would often be mistaken for parts of the leaves. The case is similar with brown ones that live on brown stems or in places more hidden from view. Some are so much like the stems themselves that the keen eye of a bird is often deceived. One of this kind is often found on ivy, and you might take it for a bit of dead twig.

4. We may then see that if at any time green caterpillars ever lived on brown stems, or brown caterpillars on green leaves, such have all been eaten up and only those have remained that are placed on the kind of plant most likely to hide them; or else the colours of their skins have changed for the same purpose; or they have grown a hairy covering which makes hiding unnecessary.

5. By what means are they placed on the most suitable plants? By the parent butterflies or moths which lay the eggs. In the last lesson we referred to the white cabbage butterfly flitting about amongst the cabbages although there were no flowers there. She was seeking a place in which to deposit her eggs. By instinct she knew that this was the place required. Although she fed on honey herself, her young ones would need cabbage leaves to eat, and as they would be green they would be also protected by that colour in the leaves. The clothes moth lays its eggs in cloth. The young eat the cloth.

SUMMARY.

1. Caterpillars are young moths or butterflies.

2. They are in the eating and growing stage.

3. They have no means of protection but their colour or hairiness.

4. The eggs from which they come are placed on plants which will supply them with food.

5. Important changes take place in the pupa state.

6. A silkworm is a caterpillar.

LESSON XXXIV.

THE HOUSE FLY.

A few dead flies on pins, and, if possible, some maggots and pupæ. Previous to the giving of this lesson, the pupils should be told to observe flies without attempting to touch them; they should especially notice how the fly drinks.

AN INSECT.

1. Observe carefully and notice the following :—

(*a*) The fly's body is divided into three parts—head, thorax, and abdomen.
(*b*) It has only one pair of wings.
(*c*) The wings are transparent, gauzy, or membranous.
(*d*) It has six legs.

2. Except in the wings, the fly bears a strong resemblance to the butterfly and moth; in fact, like them, it is called an *insect* because its body is *insected* or divided into three parts. We shall see that it also resembles them in other important particulars.

EYES OF INSECTS.

1. Look at a fly's head. Observe those two large reddish brown patches. Seen under a magnifying glass, each is made up of a great number of six-sided little faces.

2. These two patches are the fly's eyes. No wonder you cannot catch a fly, for its head seems to be all eyes. Notice :—

(*a*) The eyes are fixed; they cannot be moved except by the motion of the whole body of the fly.
(*b*) The eyes are not protected by lids like ours.

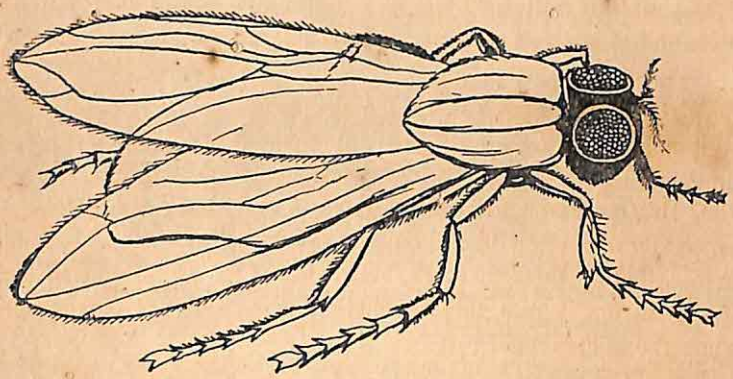

Fig. 50. The House Fly; much enlarged to show the eyes.

3. From this we may infer that the fly's eyes are not tender like ours, and we can understand that its inability to move them is compensated for, by the number of *faces* which enable it to see in various directions at the same time.

4. Such eyes as these are called *compound*, and all insects have them. You should now compare those of the butterfly and moth; they are not quite so large, but they are of the same kind. Besides these two compound eyes, many insects have between them three small simple eyes.

FOOD.

1. Children will have noticed a fly on a plate on which has been placed a small quantity of sweet liquid :—

(*a*) The fly puts out a little sucker or trunk.
(*b*) With this trunk it takes up the liquid.

2. A fly cannot eat, it can only drink. If sugar is dry, it moistens it.

3. But no doubt flies are often seen to haunt meat. This is especially the case with the large bluebottle flies. What is found in meat after their visits? Maggots. The fly is said to *blow* the meat, but it goes there to lay its eggs, and out of the eggs come the maggots.

DEVELOPMENT.

1. When young butterflies are hatched from the eggs they are caterpillars, and when flies are first hatched they are maggots. Why then does the fly lay its eggs on meat? In order that the young may get the food they require. They will eat any kind of meat, either fresh or decaying, and in this way they often act as scavengers by eating up what would otherwise, in decaying, give off very harmful gases. Thus the flies perform a special service.

2. Now notice the maggots or grubs :—

(*a*) The grubs are white.
(*b*) They have no legs.
(*c*) They cannot creep like a caterpillar.

Is it necessary for them to do so? No, because they are

placed in the midst of their food and have not to seek it. So if they had legs, their legs would be of no use to them.

3. If some of these grubs are kept in a glass jar with a piece of meat, it will be noticed that after eating and growing, they at last become small, brownish-coloured pupæ. From these, flies ultimately emerge.

4. The stages in the growth of a fly then are :—

(*a*) The egg.
(*b*) The maggot or grub.
(*c*) The pupa.
(*d*) The full-grown fly with wings.

WINGS.

1. We have noticed that the fly has only one pair of wings, and that these are membranous or gauzy. Now look just behind these wings, and a small pair of knobs will be seen, one on each side. These are just where hind wings grow in the butterfly and moth.

2. These knobs then are all the fly has, to stand for hind wings, and it uses them as balancers in flying.

3. Thus we see the fly differs from the butterfly and moth in having—

(*a*) Two wings, membranous instead of scaly.
(*b*) Balancers instead of hind wings.
(*c*) The young, helpless maggots instead of creeping caterpillars.

LESSON XXXV.

THE BEETLE.

Specimens of several kinds of beetles, including, if possible, the lady-bird. These specimens should be pinned on to stout cards or cork pads. The most humane way of killing is to pour boiling water on to the insects, when death is instantaneous. Or water beetles such as may be caught in almost any pond.

THE HOME OF THE BEETLE.

1. Children will at once recognize a common beetle, and probably be able to say where beetles may be found.

(*a*) Beetles are often found on turning up stones.
(*b*) They are often seen in the soil when it is dug up.
(*c*) Some kinds live in water.

2. There are various other places in which they may be met with, but perhaps in the ground oftener than anywhere else.

DESCRIPTION.

1. A rather foolish prejudice prevails against many of this class, but we shall find them quite as interesting as butterflies if we bestow an equal amount of attention on them.

2. Take, for instance, the common dung beetle, which may often be seen at dusk on a summer's evening as it hums by, and alights in the middle of the dusty road. It feeds on horse dung. We notice :—

(*a*) Its body is very hard and horny.
(*b*) It is of an almost black colour, but of a beautiful blue or purple underneath.
(*c*) It has six legs.

(*d*) It has two short knobbed feelers. (These are not antennæ, which would grow from the top of the head.)

3. From the mention of food above, it will be seen that it is unlike the butterfly, moth, or fly. Look for a trunk; no such appendage will be found, but short curved claw-like hooks will be seen just where a mouth might be expected to be found. Observe the way these are placed for moving. They move from the sides inwards horizontally. These are the beetle's *jaws*. (*Imitate the action with fingers and thumb.*)

WINGS.

1. Those who have seen the beetles already referred to, in the dusk of an evening, will know that they can fly. But where are their wings? Observe:—

(*a*) No wings appear as in the fly or moth.
(*b*) The greater part of the body is a smooth horny surface.

2. Lift upwards and outwards from the hinder end, the smooth horny part that covers the abdomen:—

(*a*) The beetle's body is covered with two large shields.
(*b*) Under these shields is a pair of membranous wings.

3. When the beetle flies, it spreads out these shields or *wing cases*, and flies with its wings. What then are these shields?

(*a*) They are a protection for the thin gauzy wings.
(*b*) They serve as balancers in flying.
(*c*) They are the fore wings grown thick and strong for the purpose of protecting the hind wings.

4. But why should the beetle need such strong shields for its wings when the fly has none? Where does the beetle live? Usually in the ground or under stones. It therefore needs these cases to prevent its gauzy wings from being torn.

THE BEETLE AN INSECT.

1. Observe in what respects a beetle resembles an insect:—

(*a*) It has six legs and four wings.
(*b*) Its body is in three sections—head, thorax, abdomen.

2. It is also like an insect in passing through the three states

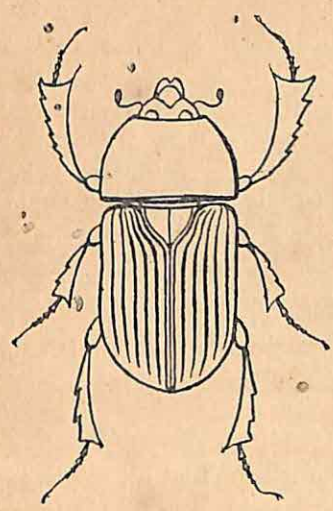

Fig 51. "Shard Horn" Beetle (*Geotrupes*) with wings closed. It has no antennæ, but two knobbed palpi are shown.

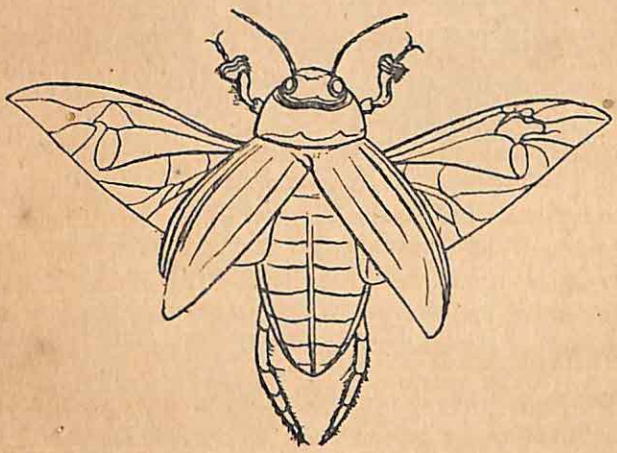

Fig. 52. Beetle with wings spread as when flying. The carnivorous Water Beetle (*Dytiscus marginalis*).

after the egg—grub, pupa, and winged creature. The difference between these states is in many instances less marked, but the beetle passes through them nevertheless.

3. We cannot count the thirteen segments in the body of a beetle, but they can be seen in the young or recently-hatched grub. The beetle is therefore an insect. Perhaps now a better name than *grub* should be introduced. Young insects before reaching the pupa stage are called larvæ (one, a larva), whether they are grubs, maggots, or caterpillars.

4. There are two other characters to be noticed. If these insects be compared with the animals treated of in former lessons, striking differences will be recognized:—

(*a*) Insects have no bones.
(*b*) They have a more or less hard covering.

It is to this covering that their muscles are attached. This hard covering is the skeleton.

5. An insect does not breathe through lungs or gills. Down each side of its body are little holes, which communicate with tubes all over the body, and it is through these that it breathes.

KINDS OF BEETLES.

1. Beetles differ from other insects in having wing-cases, consequently many will readily be recognized. The lady bird is one of the prettiest and most useful. The ground beetle is very common in the earth of the garden. The turnip fly is a small beetle, and the glow-worm is another.

2. The antennæ or horns are of various kinds—feathery, knobbed, and beaded. Some have none, but generally two feelers can be seen. These are short and grow from below.

3. There are about 3,000 kinds of beetles in the British Isles.

SUMMARY.

1. Insects are known by:—

(*a*) Having six legs, usually four wings, and compound eyes.
(*b*) Having the body in three parts, which are composed of thirteen segments.

(*c*) Passing through four states—egg, larva, pupa, insect.
(*d*) Having no bones, and breathing through tubes.

2. Butterflies are *scale-winged* insects.
3. Flies are *two-winged* insects.
4. Beetles are *case-winged* insects.

WATER BEETLES.

These may be considered preferable to those described above, and there is this advantage connected with them, that they can be observed alive in water; in fact, they may be kept in an aquarium, but if they are of the carnivorous kind (as shown in Fig. 52), they must be kept alone, for they are very fierce. The following special points should be observed:—

(*a*) The back pair of legs are large for swimming.
(*b*) The beetle comes to the surface for air, and takes it in under the wing cases as it rests head downwards.
(*c*) The antennæ are long and bead-like.
(*d*) These beetles can fly, and usually do so by night.
(*e*) The larva is very fierce, and has sickle-shaped jaws.
(*f*) These beetles do not hesitate to attack any living creature that may live in the water with them.
(*g*) The Great Water Beetle lives on plant food, and is quite harmless.
(*h*) There are many kinds of the carnivorous beetle, some quite small.

LESSON XXXVI.

THE HONEY BEE.

Piece of honey-comb, honey; a few mounted specimens of dead bees; drawings of bee, and bee entering flower; snapdragon and foxglove flower; beeswax.

HONEY AND HONEY-COMB.

1. All children know something about honey:—

(*a*) It is a thick liquid.
(*b*) It is very sweet.
(*c*) It is gathered by bees.

2. Here is a piece of honey-comb from which honey is taken (*shew a piece*):—

(*a*) The comb is made up of many little cells.
(*b*) Each cell is six-sided.

3. Notice how nicely the cells fit together; if they were round there would be spaces between. In these cells honey is stored by bees and we take the combs for our own use.

4. Melt a little of the comb. It is not made of honey, but of a substance known as beeswax (*show some*).

WHAT A BEE IS LIKE.

1. Let us now learn something about this exceedingly useful little creature. Examination of specimens should bring out the following:—

(*a*) A bee has four membranous wings like a fly's.
(*b*) Its body is in three parts, head, thorax, and abdomen.

(*c*) It is covered with a fine silky hair, coloured in bands.
(*d*) It has six legs.

2. Some combs contain young bees. These are white helpless grub-like things, which pass through a pupa stage before becoming winged bees. They have no legs, for being kept always in the comb cells from the time they are hatched until they are winged, and being fed by the old bees, they never need any.

3. We thus see that a bee has :—

(*a*) Its body in three parts.
(*b*) Four wings and six legs.
(*c*) Four stages in its life – egg, larva, pupa, and winged bee.

What then must it be? An insect.

GATHERING HONEY.

1. The bee flies from flower to flower, diving to the bottom of deep tube-like flowers and extracting small drops of sweet liquid formed there. This it sucks up by means of its long tongue which looks like a trunk.

2. Show foxgloves, snapdragons, or other similar flowers, and notice how a bee's body exactly fits the tube. No butterfly or moth could take the sweet liquid from these.

3. When the bee has sucked up the liquid, it swallows it, and keeps it in a bag in its throat until it gets to the comb in which the store is to be kept. Then the liquid, which has undergone a change and become honey, is discharged into the cells to be saved for future use.

4. Bees also collect, in little bags on their hind legs, yellow dust (pollen) out of flowers, and this they mix with honey to feed their young. In visiting flowers they also carry considerable quantities of pollen unintentionally from one flower to another.

5. Besides this, bees make wax. This is formed in their bodies, and is squeezed out through small holes, or from small sacs in the joints of the segments of which the body is composed (for the bee's body is in segments like that of other insects). Of the wax, the bees make the cells and also stop them up when they are filled with honey.

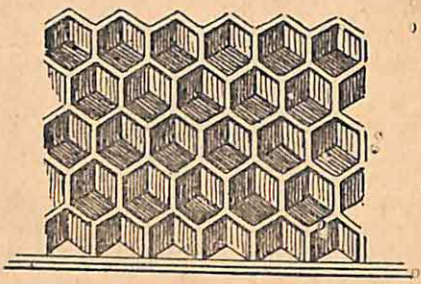

Fig. 53. Artificial Cells made for the bees, like their own.

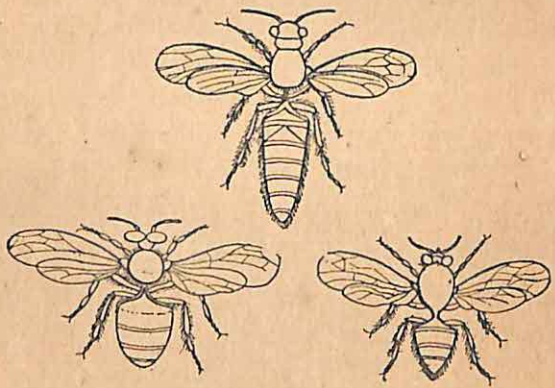

Fig. 54. Hive Bees.—Upper figure, the queen; to the left, a drone or male; to the right, a worker or neuter.

THE HIVE AND ITS ECONOMY.

1. Children will probably know :—

(*a*) Some bees make nests in the ground.
(*b*) Some bees are kept in hives.
(*c*) Bees have stings.

2. We shall be content to speak of the hive bees. The intelligence they show in working together and helping one another is very wonderful.

3. Every hive contains :—

(*a*) A queen.
(*b*) A few males or drones.
(*c*) A great number of workers.

4. The queen only lays eggs; the males are called drones because they do no work, and they have no stings; the workers are small females that never lay eggs, but they do all the work of collecting honey, making the cells and nursing the young.*

5. When a young queen has been hatched, the old queen goes off to find another place to make a hive, and great numbers of workers go with her. This is called *swarming*. The old drones are killed off every autumn.

BEES AND FLOWERS.

1. Bees show great intelligence in being able to find their way back to the hive when a long distance away.

Their eyes are easily seen, and we may readily infer that they can smell too. How does a bee know where a flower is? It can see the colour. Yes, and it can, no doubt, smell the sweet odour. In fact it may be taken for certain that flowers possess odours and colours for the purpose of guiding insects to the place where the sweet liquid is stored, so that by their visits the

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* Many female insects have an organ called an ovipositor, with which they *place their eggs*. The stings of bees are modified ovipositors. A worker bee cannot withdraw its sting—so after stinging, it dies.

pollen may be carried from one flower to another. (See "Object Lessons in Botany," Book II.) And we have seen that several flowers are also so shaped as to exactly admit the body of a bee. Therefore bees not only supply wonderful examples of industry, co-operation, and intelligence, but they also present remarkable instances of creatures adapted for certain work, and the means for doing that work being specially fitted to them.

LESSON XXXVII.

THE SPIDER.

Some spiders and spiders' webs; picture or large drawings of both. A cocoon of silk.

A SPIDER'S WEB.

1. (*Show spider's web.*) Every child knows something of a spider's web, and will soon tell:—

(*a*) Spiders spin webs.
(*b*) Webs are found in unswept corners of rooms.
(*c*) They are also often seen on hedges early on a summer's morning covered with dew.

2. Notice how the web easily sticks to the fingers or clothes. This is because it is made of very fine threads, finer even than those of the silkworm.

3. Next observe a web as shown in Fig. 55 (the web of the garden spider). *Show a drawing on a large scale:*—

(*a*) The web is like a wheel.
(*b*) It has spokes extending from the centre outwards.
(*c*) A thread runs round and round in the form of a spiral.

THE WEB-SPINNER.

1. Now we want to find out two things—why a spider spins a web, and how he does it. Children can answer the first question:—

(*a*) A spider spins a web to catch flies.
(*b*) When a fly's feet are entangled in the threads of the web, out comes the spider, binds the fly fast, and then eats it or saves it for future use.

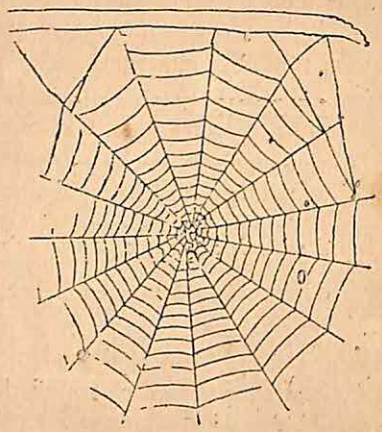

Fig. 55. Garden Spider's Web.

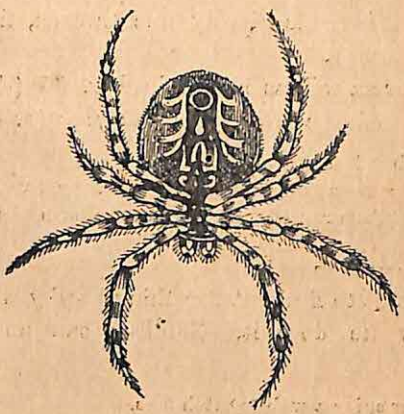

Fig. 56. Garden Spider, head downwards as suspended by a thread; viewed from the under side.

2. Children will most probably not have seen a web made. In the first place it is, as has been said, composed of fine threads. Each of these threads consists of a number of others twisted like a very fine rope. On the lower side of the spider's body there is a great number of minute holes, which are able to let out a quantity of gummy fluid from a bag inside the body. (Get a little treacle on a spoon or stick, touch some object, and then gently withdraw; a long fine thread is formed.) This is how the spider acts. It causes the gummy fluid to stick to something and then withdraws. Out of all the holes the liquid is drawn; all the threads become one, and harden on exposure to the air.

3. It is interesting to know how a garden spider spins its wheel-like web. Children may well exercise a little thought on what might be the spider's mode of procedure.

Which must be made first, the spokes or the spiral? The spokes, for there would otherwise be nothing to fasten the spiral to. A drawing will show how the work is carried out. Take a centre, draw radiating lines to some objects on the circumference; let these represent the spokes. The spider starts from the centre, runs a short distance along one spoke, fastens its web there, then returns drawing a lengthening thread; advances an equal distance along the next spoke, draws the thread tight across and fastens it there. This goes on until the spiral is completed.

THE SPIDER ITSELF.

1. Examine one of these creatures:—

   (*a*) The spider's body consists of two parts, the head and a large rounded part. (The head and thorax form one part.)

   (*b*) It has eight legs.

   (*c*) It has no wings.

2. Look for the eyes. No large compound eyes are to be seen, but several small dot-like eyes about the sides of its head, eight in all, and simple not compound eyes.

3. In places frequented by spiders, sometimes small bundles

of little white eggs are to be found, surrounded by a covering of web. From these, young spiders are hatched, not grubs, caterpillars, or larvæ.

COMPARED WITH AN INSECT.

1. We see at once then that a spider differs much from an insect:—

(*a*) Legs—a spider has eight, an insect six.
(*b*) Wings—a spider has none, an insect usually two or four.
(*c*) Body—a spider's body is in two parts, an insect's in three.
(*d*) States—a spider does not pass through different states, an insect passes through three after leaving the egg.

2. To these may be added another. A spider does not breathe through tubes, but it has a small lung.

So a spider is not an insect.

LESSON XXXVIII.

A SHRIMP.

A sufficient supply of shrimps to give each child one; a pin or ordinary steel pen; (well wash the specimens first); drawing to show lower side of animal. The shrimp is taken as a typical crustacean because each child can have a specimen. In some localities crayfish may be obtained; where such is the case they might be substituted, and boys should be previously sent to catch specimens. Crayfish are killed by being dropped into boiling water. A lobster would be useful in either case to show the parts on a large scale. Shrimps will perhaps be better for use after being kept a day or two in methylated spirit. They should be carefully dried in a cloth before distribution.

PROMINENT CHARACTERS.

1. Shrimps are caught in the sea and largely used for food. A first observation will reveal the following:—

(*a*) The shrimp's body is covered with a hard shelly coat.
(*b*) On the head there are two very long antennæ.
(*c*) The tail is curved almost underneath the body.

2. Seeing the body is covered with a shelly coat, what enables the creature to bend its tail? The hinder part of the body is jointed. Count the joints, and also notice the covering of the fore part.

(*a*) The hinder part of the shrimp's body is composed of six segments, or has six joints.
(*b*) The covering of the fore part and head is all in one piece.

This large piece is sometimes called a carapace, like that of the tortoise. The lobster or crayfish should be compared. In the case of a crab, usually nothing but the carapace is seen.

3. Look more carefully at the head :—

(*a*) The eyes are like two black beads on the top of the head.
(*b*) Between the long antennæ is a pair of short antennæ.

A little pressure in this region will show that over the base of each of the long antennæ is a broad fringed piece or projection. Touch the eyes with a sharp point; they will be found to be movable; in fact, they are at the ends of little stalks—eye-stalks, as they are called.

LEGS.

1. Another striking character of this animal is its large number of legs. Turn the creature over and find :—

(*a*) Five pairs of legs on the five segments of the hinder part of the body.
(*b*) The tail with a two-bladed piece on either side of it.

2. These *two-bladed* pieces grow on the sixth of these segments; and, regarding the tail as another segment, there are :—

(*a*) Seven segments in the hinder part of the body, and
(*b*) Six pairs of limbs—one pair to each of the first six; the seventh (the tail) is without.

3. Observe now the thicker part of the body. The legs here are longer, and are placed in pairs. Count along one side, beginning from behind :—

(*c*) Two pairs of long, rather strong legs.
(*b*) Two pairs of very thin pale coloured legs.
(*c*) One pair of long legs with pincers at the ends.

The middle two pairs (*b*) can only be seen by carefully pressing the others away. Compare the small pincers with large ones of lobster or crayfish.

MOUTH.

1. Now press back the pincers. Another pair of what appear to be legs will be seen stretching forward underneath the antennæ. Between these two legs will be seen a small hole, fringed round; this is the mouth. With a sharp point these two legs may be pressed back, when others will appear. These are smaller, but they all carry a kind of fringe, which surrounds

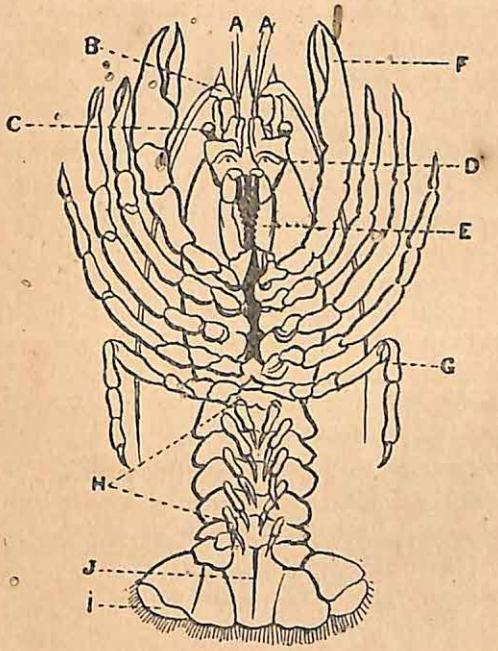

Fig. 57. Crayfish from below.

A, first pair of antennæ; B, second pair of antennæ, bent backwards; C, eyes; D auditory organs; E, foot-jaws; F, first pair of legs; G, fifth pair of legs; H, five pairs of swimmerets; I, tail fin; J, tail or terminal segment.

the mouth. In fact, there are six pairs (though it may not be easy for every child to discern them), and they act as jaws to the mouth and do the work of eating. Shrimps feed on animal matter found in the water.

2. The work of the pincers may readily be surmised. With these the animal seizes its food; it then passes it to the legs behind the pincers, which in turn pass it on to the foot-jaws round the mouth. These work sideways, and cut it up. The shrimp has no other teeth than these foot-jaws, except a kind of mill in its stomach.

WALKING AND SWIMMING.

1. Considering now all the legs or limbs of the shrimp, it will be seen that there are not many to walk with: why?

(*a*) The hinder ones are too short.
(*b*) Six pairs are used as jaws.
(*c*) The pincers and two pairs catch and carry the food to the foot-jaws.
(*d*) Only two pairs are left for walking purposes.

2. No doubt the pincers are used for taking hold of objects so as to help the shrimp along, but there are but two pairs of simple walking legs. What then are the short ones used for? They are used for swimming, and are generally called *swimmerets*.

3. But what is the use of that broad tail? It is bent under the body. Imagine it straightened out, then while in the water suddenly brought under the body. The broad surface would press against the water, and the animal would be forced along. In what direction? (Illustrate the action with the bent hand.) Backwards. It is usually by the action of the hinder part of the body that the shrimp thus swims, and always backwards. When it wants to go forwards, it uses the five pairs of swimmerets, but it can only go slowly in that direction.

OTHER CHARACTERS.

1. Often a large number of small bead-like bodies are collected round about the swimmerets and walking legs. These are eggs.

2. Carefully lift up the side of the carapace, and underneath will be seen some thin white leafy folds. These are the gills. The shrimp's blood is purified by the water passing through these gills.

CRUSTACEANS.

1. Shrimps, lobsters, crayfishes, and crabs have all hard shelly coverings. Moreover, they resemble each other in their general structure, a shrimp being as much like a lobster as a fly is like a beetle. Accordingly, these shell-covered animals, which certainly resemble one another more than they resemble any other animals, are considered as one class, and are known by the name *crustaceans*, from their hard covering.

2. Taking, then, what we have learnt of the shrimp, and adding one or two points of information, the characters of a common crustacean may be thus stated :—

(*a*) It has a shelly coat or skin.
(*b*) Its body is jointed (21 segments altogether).
(*c*) It has a pair of limbs on every segment but the tail.
Six pairs of swimmerets (counting the broad pair).
Two pairs of walking legs
Two pairs of feeding legs
One pair of pincers
} These are the five pairs of legs most easily seen and characteristic of a Crustacean.
Six pairs of foot-jaws.
Two pairs of antennæ.
One pair of eye-stalks.

LESSON XXXIX.

THE EARTHWORM.

Several living specimens displayed on a moist plate or slate; pot of earth; worm casts.

THE EARTHWORM EXAMINED.

1. Place some earthworms on a plate and observe them carefully :—

(*a*) The body of the earthworm is long and round—*cylindrical.*

(*b*) It contains no bones, and is bent easily in any direction—*flexible.*

(*c*) It is about three, four, or five inches in length, and pointed at one end.

(*d*) It has no legs, eyes, or ears that can be seen.

2. Observe how a worm moves along without the aid of legs or feet :—

(*a*) The body is made up of numerous ring-like parts (sometimes over 300).

(*b*) The pointed end moves onward, so this must be the fore part.

(*c*) The fore part holds to the ground, while the hinder part is drawn up by the closing of the rings, like the bellows of a concertina.

(*d*) Then the fore part is again pushed forward.

HABITS.

1. What is known by the children of the habits of earthworms :—

(*a*) Earthworms are found in the earth, hence the name given to them.

(*b*) They are plentifully seen, after a shower of rain, on the surface of the soil in gardens.

(*c*) They come out of holes in the ground—their *burrows*.

(*d*) They do not entirely leave their burrows, but keep the tail end of the body within.

(*e*) If they are alarmed, they hastily crawl backwards and disappear.

2. But what do these worms eat? Leaves are regularly dragged into their burrows. Some of these are eaten, but they also line the sides of the burrows with them. If some worms are kept in a moist soil in a pot, it will be found that they will eat cabbage, onion, celery, &c. *They do not injure growing plants.*

3. Now how can worms make burrows if they have no feet to scrape out the soil? They have mouths, for they eat; or rather they have what serve for mouths, merely a hole which has the power of drawing in. They eat the soil as they go burrowing down, and pass it through their bodies, forming at the top little heaps of earth known as worm casts. Examine some.

4. If you try to pull a worm from its burrow, you run the risk of either letting it slip through your fingers or breaking the creature in two; but if you ease it a little, let it withdraw itself while you retain your hold, and then suddenly pull up, it is brought out easily. The reason for this is that the worm has several bristles along the sides of its body, and these it sticks into the sides of the burrow to resist being taken out.

5. Worms come out to eat in the night. If you go out in the dark with a candle, and tread very carefully, you may find numbers of them on the surface of the soil with their tails in their burrows.

SENSES.

1. Whether worms can see, hear, or smell, is a subject which Mr. Darwin most carefully investigated. A few of his experiments may be repeated; or, if that is not possible, they may be stated, and the children should be able to draw the inferences from them.

EXPERIMENTS.

1. Worms were kept in a pot of soil. When the worms were

on the surface, the pot was placed on a piano and several notes were sharply struck. The worms at once retreated to their burrows.

2. The same pot with worms on the surface was placed on a stand near the piano, and the notes struck as before. The worms took no notice; inferences:—

(*a*) The worms did not hear the sound.
(*b*) In the first experiment they felt the vibration.

3. When worms are out after a shower of rain, if you walk boldly up to them they retreat, but if you walk carefully so as to cause no vibration of the ground, you may make as much noise as you like; they take no notice. This bears out the above inferences.

4. When a strong-smelling breath was breathed over some worms, they took no notice, though several odours were tried.

5. When food was buried in the soil they found it, but onion and other favourite foods were first found; inferences:—

(*a*) Earthworms have some sense of smell.
(*b*) They can only perceive odours that they know.

6. A light from a lens was directed upon some earthworms; they only withdrew after it had been shining on them for a long time.

7. Earthworms always come out at night; inferences:

(*a*) Earthworms have little sense of sight.
(*b*) Perhaps all they can do is to distinguish dark from light.

USES.

1. The chief service of earthworms is that of lightening the soil. Mr. Darwin carried out a long series of interesting observations and experiments in this direction. He collected, dried, and weighed all the worm casts on certain areas of ground for a year, and found out that on an average the worms living in an acre of land throw up more than 14 tons of soil in a year! It is easy to see that in the course of a few years the whole soil, to a certain depth, must be overturned and lightened by these

silent little workers. This is one reason why lawns require rolling.

2. It is also believed that worms, by an acid which they give out from their bodies, dissolve hard stone, which is thus formed into soil.

For further points of interest, see Darwin's "Formation of Vegetable Mould through the action of Worms, with Observations on their Habits.")

LESSON XL.

THE COMMON SNAIL.

A snail in shell; some empty shells; a plate.

THE SNAIL AND ITS SHELL.

1. Place a snail in its shell on a wet plate; observe:—

(*a*) The snail pushes out a part of its body and begins to crawl on the flat part that touches the plate.

This flat part is called the foot.

(*b*) It sends out four horns.

(*c*) The horns spring from the upper side of one end of the foot.

2. This is really the snail's head; just below is the mouth. Touch one of the horns; it is immediately withdrawn. These are therefore not true horns, for they can be bent about, pushed out or drawn in. They are better called *tentacles.* Look at the ends of the long tentacles. Round knobs are seen; these are the snail's eyes.

3. Now examine the shell. Part of the snail's body is always inside it. Observe:—

(*a*) The shell is in form of a spiral.

(*b*) The shell is largest at the mouth or opening.

(*c*) It is made larger by adding to the edge at the mouth.

Turn the shell round between the fingers, and cross lines will be seen showing how layer after layer has been added. Once the shell was only of the size of the very centre of the spiral. It will easily be understood how it has been enlarged, if the further enlargement is considered. When the snail is little it has a little shell, but as it grows, its house must be made

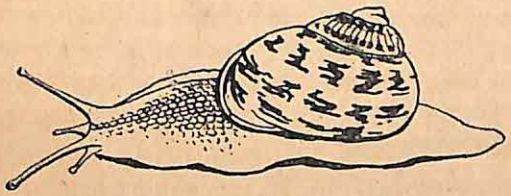

Fig. 58. Common Garden Snail.

larger. It cannot therefore live in the small part when it has grown large.

HOME AND FOOD.

1. Snail shells are of various colours, sizes, and shapes. Where may such be found? On leaves, under stones, in water.

2. The food of snails is evident to anyone who has a garden. They eat green leaves with great readiness, especially when they are damp. Why should they be damp? Because the snail can crawl more easily on a wet surface. If the surface is not wet, it must pour out slime to make a path. The slime is often seen when it is dry, and then we know that a snail has been crawling there.

3. Some have no shells, and are especially troublesome in eating lettuce and other plants. These are called slugs.

4. If snails do much damage to plants it becomes necessary to rid the garden of them, but they should be killed by being covered with salt, and not by crushing. A snail has what may be called two brains, and if only one is crushed, the animal may suffer great pain at the other.

FURTHER DETAILS.

1. The snail has a small lung by means of which it breathes.

2. That part of the body just outside the shell is the collar, and it is here that the stuff is given off which builds the shell larger and larger.

3. In winter the snail withdraws its foot into its shell and stops up the entrance with slime. Why should it retire in the winter? There is no food obtainable, so the best thing it can do is to go to sleep until spring comes again.

4. Snails lay eggs. These may often be found in the earth of the garden. They are like little pearl beads, each about a quarter of the size of a pea. From them young snails are hatched by the warmth of the sun.

5. Water snails may be kept in an aquarium; they will lay their eggs on the glass where they can easily be observed.

LESSON XLI.

SHELLS.

Several shells, both univalve and bivalve, such as the following:— snail, periwinkle, whelk, cowry, olive, woodcock; oyster, mussel, scallop, cockle, &c.; a fresh oyster.

MOLLUSKS.

1. Snails are not the only creatures that live in shells. There are oysters, cockles, mussels, whelks, periwinkles, and others. These live in water, and are often spoken of as *shell fish*. In this lesson we shall see how little they are like fish.

2. Here are some shells, empty now, but once occupied. Take the oyster or mussel for example. *If possible, open a fresh oyster.* Those who have seen these shells opened will know:—

(*a*) Oysters hold their shells very tightly closed.
(*b*) When opened the shell is seen to contain only a soft mass.
(*c*) In its softness and slipperiness, the oyster is like a snail.
(*d*) It is also like a snail in having a shell.

3. The other shell creatures are similar, and, like the snail, they cannot leave their shells; they can only put out a portion of their bodies, generally the foot.

4. Fig. 59 is a picture of what a cockle is like when in the water. If danger threatens, the foot is quickly withdrawn and the shell tightly closed. The cockle leaps by means of its foot.

5. All these soft-bodied creatures, most of which, like the snail and the oyster, have shells, are called *mollusks*. Some mollusks are eaten as food. Snails are eaten in France.

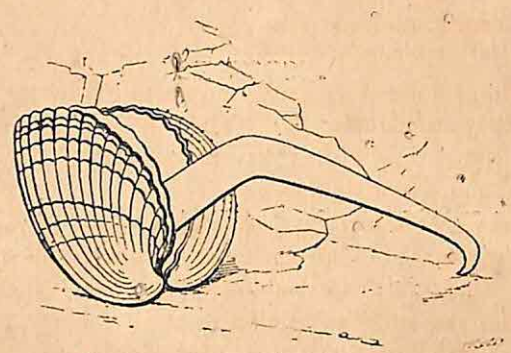

Fig. 59. Cockle Walking (bivalve shell).

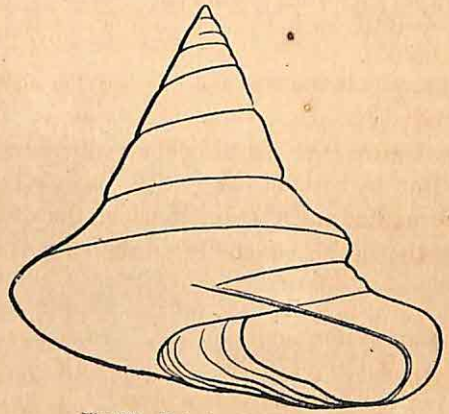

Fig. 60. Univalve Shell (trochus).

UNIVALVES AND BIVALVES.

1. Now although these shells are so different in form and size we may divide them into two classes :—

(*a*) Those made in one piece.
(*b*) Those made in two pieces.

2. We have noticed these two pieces in the oyster, cockle, and mussel; they are called *valves*. The fitness of this name will be seen on comparing with the valve of a pair of bellows, that opens and shuts in a similar way.

But these halves having received the name valves, it became the habit to speak of such shells as two-valve, or *bivalve* shells. Then the others were called one-valve, or *univalve* shells, although they had no resemblance to a valve at all (except, perhaps, the limpet). So we have two classes of shells :—

(*a*) Univalves.
(*b*) Bivalves.

3. Examine several univalves :—

(*a*) The snail shell is a univalve.
(*b*) Univalves are formed in a spiral.
(*c*) The spiral is a kind of tube gradually increasing in width as it extends.
(*d*) The increase in size is to accommodate the mollusk as it grows larger.

In some univalves the spiral is not easily seen, for instance, the cowry. But by careful observation it may be seen at one end, the large mouth, and the way in which the shell is enlarged, tends, to bury the spiral, but the beginning of it is evident.

BIVALVES.

1. Examine an oyster shell :—

(*a*) The oyster shell is a bivalve.
(*b*) The two valves are joined by a hinge.
(*c*) The outside is very rough and formed in layers.
(*d*) The inside is very smooth and pearl-like. (Pearls are taken from certain kinds of oyster shells.)
( ) In the middle of the inner surface there is a dark scar.

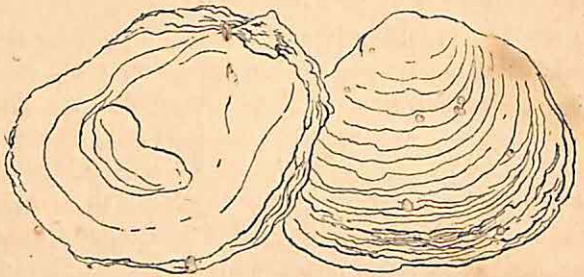

Fig. 61. Bivalve Shell of Oyster. The outside view shows the layers, the inside a scar or place of muscular attachment between the mollusk and its shell.

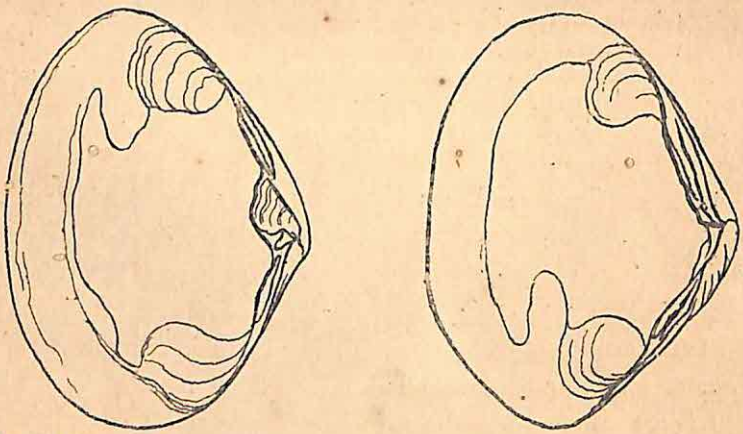

Fig. 62. Bivalve Shell; inside views of valves to show the mantle line, and the two scars or places of muscular attachment in each.

2. What is this dark scar? There is one on each valve. This is where the mollusk holds each valve by a strong muscle, so that it can quickly and tightly close the two together.

Before an oyster can be taken out of the shell these muscles must be cut.

3. Now look inside the valves of a mussel or others that may be at hand. In some no scar is seen in the middle, but on each valve two are seen, one near what is the fore part, and the other near the hinder part (see Fig. 62). Such mollusks hold their valves together by two strong muscles on each side.

4. Notice also the curving line running parallel to the edge from one scar to the other. In some shells it is but faintly seen; in some it has an inward bend near the hinder muscle; in others it has not. So we see these bivalve shells may have:—

(*a*) One large central scar on each valve, or
(*b*) Two large scars on each valve, that is, the mollusk has two clasping muscles on each side.

And again those with two scars may have:—

(1) A line from scar to scar with an inward bend.
(2) A line from scar to scar without such a bend.

HOW A SHELL IS ENLARGED.

1. We have noticed the layered appearance of the outside of the oyster shell. Now how can the mollusk enlarge its shell as it grows? It is inside and can only work within. Think how a man places tiles or slates on a house. But he works from the outside. Take several pieces of paper and place them one under the other so that the second projects further than the first, the third further than the second, and so on. This will illustrate how the mollusk adds to its shell.

2. Crush an oyster shell; a lime-like mass is produced. All these shells are composed of lime which the mollusk takes from the water in which it lives.

3. A bivalve mollusk has a special organ for forming the shell layers. This is called the *mantle*, and the lines noticed in some

shells are the mantle lines. (The peculiar bend in this line is due to the presence of what are called siphons.)

A MOLLUSK AND A FISH.

1. Differences :—

   (*a*) A fish has bones, a mollusk none. (The shell is, however, a kind of external skeleton.)

   (*b*) The body forms are quite different.

2. A point of likeness is that in bivalves at least, the breathing takes place through gills.

SHELL COLLECTING.

This is a very instructive and interesting hobby, and children may well be encouraged in it.

LESSON XLII.

CORAL.

A piece of white coral and a piece of red. Picture; drawing; picture of coral island, map of Australia or Pacific Ocean.

A PIECE OF CORAL.

1. Examine a piece of white coral:—
   (*a*) Coral is a very hard, stony substance.
   (*b*) It is white and lime-like.
   (*c*) It is full of small holes like little nests.
2. Compare a piece of red coral:—
   (*a*) Red coral is also stony.
   (*b*) But it is in long tubes, and not made up of little cells.

CORAL ISLANDS.

1. Coral is found in the sea. The red is found in the Red Sea. The white coral exists in great masses in various parts of the Pacific and Indian Oceans.

2. Refer to a map of Australia, or the Pacific Ocean. Numerous islands will be seen dotted about. Some are in the form of more or less regular rings. Many of these islands, certainly the ring-shaped ones, are made of coral.

3. Refer to the map of Australia. On the north-east there will be seen represented on the map what is known as a reef. It is made entirely of coral. It is a mountain range in water a thousand feet deep. It reaches the surface, and runs more than a thousand miles along the coast, sometimes at a distance of fifty miles from it. It is very dangerous to ships.

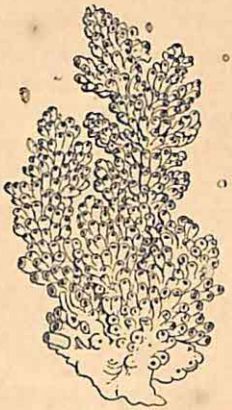

Fig 63. White Coral.

Fig. 64. Red Sea Coral.

CORAL BUILDERS.

1. All this coral is built up by small animals generally spoken of as corals (sometimes called coral insects, but incorrectly so).

2. Look again at the white coral. Each little hole has been the home of one of these creatures. In fact, it would be more correct to say that the *walls* of each little cell are the skeleton of one of these little creatures, just as an oyster shell is the skeleton of the oyster—not a skeleton like ours, inside, but an outside skeleton. The creatures remain in their cells or skeletons, and push out their tentacles (see Fig. 63).

3. The corals live in colonies, and young ones fix themselves on the skeletons of the old ones. Thus they continue to build up a mass that, beginning on the floor of the ocean, in time reaches its surface.

4. Corals are only found in warm seas. They live on minute particles taken in from the water. Like the mollusks, they build their skeletons of the lime which they take in with their food.

LESSON XLIII.

SPONGE.

Several pieces of sponge, a drawing of a sponge particle as shown on page 193*; if possible, some form of ornamental sponge, like Venus's Flower Basket; a fresh-water hydra or drawing of it.*

A SPONGE.

1. Examine a piece of sponge (if possible, each child should have a piece), and observe :—

   (*a*) Sponge is very light.
   (*b*) It is full of holes.
   (*c*) Some holes are large and like passages.

2. Squeeze the sponge :—

   (*a*) It is soft.
   (*b*) After being squeezed it easily goes back to its former size and shape.

We therefore say it is *elastic*.

3. Try to tear the sponge. What kind of material is it made of ?

   (*a*) Sponge is tough.
   (*b*) It is made of a kind of soft horny substance.

4. Dip it in water :—

   (*a*) Sponge readily takes up a large quantity of water and holds it.
   (*b*) The water in the large passages runs out.
   (*c*) The sponge must be squeezed to get out the remainder.

5. Cut through a sponge and expose the passages.

6. Sponge then is light, elastic, soft, tough, and readily absorbs and holds water; for these reasons it is very suitable for washing soft and delicate skins. It is often much better than linen or calico.

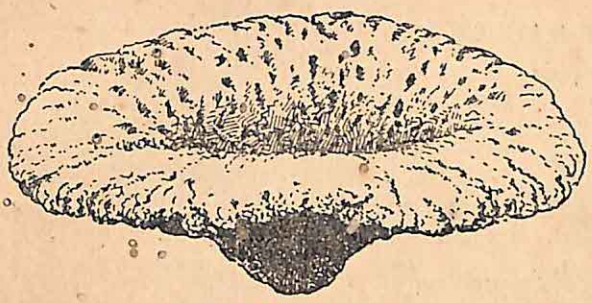

Fig. 65. A Sponge.

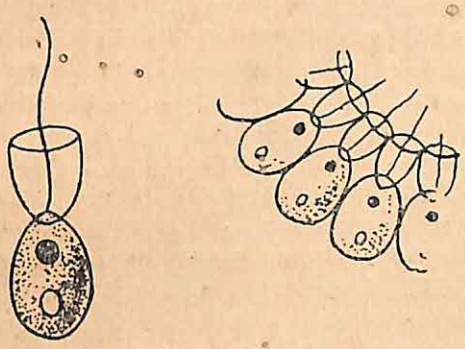

Fig. 66. Sponge Particles (one individual magnified about a thousand times) showing cilia and nuclei.

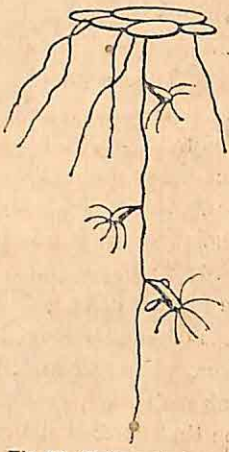

Fig. 67. Hydras attached to root of duckweed.

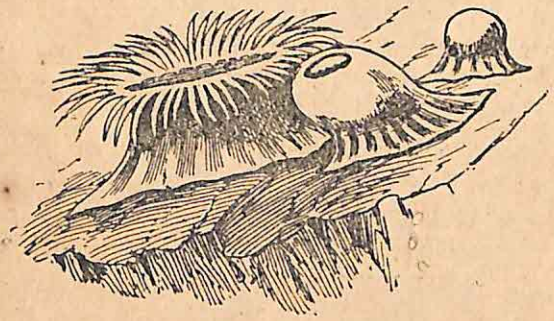

Fig. 68. Sea-anemones attached to rock; one partially and one entirely closed.

SPONGE MAKERS.

1. How is sponge made, or does it grow? Whence do we obtain these useful articles? Sponges, like corals, are found in the sea. They grow on rocks as shown in Fig. 65, and look like plants. Divers go down to cut them away and bring them to the surface. The Mediterranean is a great hunting-ground for them, especially near the shores of Greece.

2. But a sponge is not a plant. When growing on the rock, all its passages are partly filled with a mass resembling the white of egg. Through these passages, too, streams of water are continually passing.

3. In various parts of the sponge there are groups of small particles or animals like the one shown in Fig. 66, and these by the motion of the whip-like hairs cause the water to flow through the passages. It has been said that a sponge is like a colony or town in which all the inhabitants live in the streets, and catch their food as it flows by them.

4. The sponge, as we get it, is the skeleton of the colony; it is formed or secreted by the sponge animals. The animals cannot of course leave it, and they have no power of moving about from place to place. Unlike the corals, they do not go on building until they reach the surface, and one reason would seem to be that their skeletons, not being hard like the coral, could not resist the action of the water to break them.

HOLLOW-BODIED ANIMALS.

1. Both corals and sponges are found in warm seas. We have, however, an animal in many of our ponds somewhat resembling them, but it builds up no skeleton. It is called a hydra, because, cut it up as you may, each part will grow into a new animal; and an old story is told of a very fierce but fanciful monster with many heads that was able to grow seven heads in the place of every one that was cut off. The true hydra is a very small thing, and it attaches itself to roots or weeds in the water.

2. It seems strange to talk of animals that have no legs, heads, or mouths properly so called; that can neither see, hear, taste, nor smell. But these animals are such. The inside of the body is a hollow place; water goes in and out continually, hence they are called *hollow-bodied*. Those children who live near the sea, or who have been to the seaside, will have seen the *sea-anemone*. It is not a flower, as the name would lead us to expect, but one of these hollow-bodied animals. It sticks to the rock, and the large opening at the top of the body is fringed round with a beautiful ring of brightly-coloured tentacles, giving it the appearance of a flower. Some of these animals have the power of stinging with these beautiful tentacles.

3. It should also be noticed that all sponges are not horny and soft like the one we know so well. Some are hard. The ornament called Venus's Flower Basket is one of these.

LESSON XLIV.

CLASSIFICATION.

(A SUMMARY.)

Pictures of as many types treated in the foregoing lessons as possible.

DIFFERENCES, SMALL AND GREAT.

1. We have learnt now a great deal about various kinds of animals, and it is now time to make some attempt at summarizing the facts that have been gathered. To do this, we will consider how much alike and how different many of these animals are, so that we may group them in classes. Children at school are placed in classes according to what they can do; animals are placed in classes according to the way in which they are made.

2. If we compare a cow and an oyster, the differences are so great that at first sight there seem to be scarcely any points of likeness. Yet both are animals. A cow and a fish, or a cow and a bird, are less unlike; but if we come nearer, and take a cow and a horse, the two animals are so much alike that the differences are easily enumerated:—

(*a*) A cow is two-toed, a horse one-toed.
(*b*) A cow is a ruminant, a horse is not.
(*c*) A cow has horns, a horse has not.

3. A cat differs from a cow, but not so much as a fish or a bird, as follows;—

(*a*) A cat eats flesh, a cow grass.
(*b*) A cat has flesh teeth, a cow has grinding teeth.
(*c*) A cat has claws, a cow has hoofs.

4. But a cow differs from a fish in:—

(*a*) Having warm blood.
(*b*) Having lungs to breathe air, not gills to breathe water.
(*c*) Supplying its young with milk; a fish lays eggs.
(*d*) In having limbs to walk with; a fish has only fins.

5. So we see a cat, a cow, and a horse, different as they may be, are much more like one another than they are like a fish, or a bird, or an oyster.

6. One respect in which the cat, cow, and horse are alike, is that they supply their young with milk, which the young suck from their mothers' teats. In a previous lesson we have referred to the name that is given to such animals in consequence—Mammals.

CLASSES AND THEIR CHARACTERISTICS.

1. Let us now make out a list of classes, and briefly indicate their characters, or the ways in which they differ from others, together with examples:—

(*a*) **Mammals**: Suckle their young.
Including *Flesh-eaters*—Cat, dog, lion, fox, &c.
Grass-eaters—Ruminants (two-toed): cow, sheep, deer.
Not Ruminants (one, three, or five-toed): horse, elephant, &c.
Rodents—Rat, mouse, rabbit, squirrel.
Insect-eaters—Mole, hedgehog, bat.

Amongst the mammals, the whale and dolphin, besides several other sea-animals, have to be included, for they breathe through lungs and suckle their young. Whales cannot live under water long, they must come to the surface to breathe.

(*b*) **Birds**: Have feathers and beak; lay eggs. *E.g.*, hen, duck, owl, canary, &c.

(*c*) **Fishes**: Fins and scales; cold-blooded; breathe through gills. *E.g.*, herring, cod, haddock, plaice, minnow.

(*d*) **Reptiles**: Cold-blooded; breathe through lungs; lay eggs. *E.g.*, snake, crocodile, lizard, tortoise.

(*e*) **Amphibians**: Cold-blooded; breathe through gills in early life, through lungs later (hence the name). *E.g.*, frog, toad, newt.

(*f*) **Insects**: Body in three sections, these being made up of segments; legs, six; wings, four; eyes compound; pass through four stages. *E.g.*, moth, butterfly, bee, beetle, house-fly.

(*g*) **Spiders**: Body in two sections; legs, eight; wings, none; eyes simple.

(*h*) **Crustaceans**: Covering of body, shell-like; legs, ten; eyes on stalks; pass through stages of development. *E.g.*, Crayfish, crab, lobster, shrimp, prawn.

(*i*) **Worms**: No limbs; no shell; no eyes; soft bodied. *E.g.*, earthworm.

(*k*) **Mollusks**: Soft-bodied; usually covered with shell; no limbs. *E.g.*, snail, oyster, mussel, cockle, &c.

(*l*) **Hollow-bodied Animals**: *E.g.*, sponges, corals, hydras, and sea-anemones.

TWO GREAT CLASSES.

1. Now a few of these classes may be grouped more closely together, for instance, the Insects, Spiders, and Crustaceans have certain features in common, and are sometimes classed together as *Jointed Animals*.

2. But the whole eleven classes may be grouped into two great divisions. Take the Mammals, Birds, Fishes, and Reptiles; what have they which the others have not? *Bones*. These animals all have a bony skeleton inside the body, and part of this bony skeleton is a backbone, made up of a number of small bones fitting together. Each of these is called a *vertebra*. Animals having these are called *Vertebrate*, and those not having them *Invertebrate*.

3. Let us now group the classes in these two divisions:—

(*a*) Vertebrate—Mammals, birds, fishes, reptiles, amphibians.

(*b*) Invertebrate—Jointed animals, worms, mollusks, and hollow-bodied.

All these, and some classes which for reasons stated below are omitted, constitute the Animal Kingdom, all other things being included in the mineral or vegetable kingdoms.

4. Perhaps the class of the animal kingdom which includes the greatest number of different kinds is that of the Insects. Of these there are known in the world 260,000 different species,

and 12,000 of these are found in England. Many kinds are still unknown.

5. The myriads of animals living in water far surpass all those found on land; and the number of eggs they lay at a time is amazing. An oyster is said to lay a million at a time; but only a very small number of these grow to be oysters, they are devoured by sea animals; hence the need for so many eggs.

Note.—1. In this survey of the animal kingdom some great classes have been omitted, notably the Monkeys, Marsupials, and Edentates, because no type was considered sufficiently accessible for the purpose of object teaching on the lines which have been followed in this book.

2. These lessons can only be considered as introductory, and children should be encouraged to follow them up by observation and reading.

LESSON XLV.

MODIFICATION
OF
LIMBS AND OTHER PARTS.

(A SUMMARY.)

In many of the foregoing lessons we have noticed the ways in which limbs or other parts are specially fitted for the work they have to do, or the kind of life the animal leads; it will be useful now to bring together as many of these instances as possible. The children should supply these facts, helped, of course, by judicious suggestion or question.

MAMMALS.

1. Cat.
   - (*a*) Teeth for tearing and cutting.
   - (*b*) Feet for seizing.
   - (*c*) Tail for keeping feet warm when resting. *Cf.* squirrel.
2. Cow.
   - (*a*) Teeth and stomach for feeding on grass.
   - (*b*) Feet hoofed for walking where grass grows.
   - (*c*) Tail for driving away the flies. *Cf.* horse. Contrast deer, sheep.
3. Squirrel.
   - (*a*) Teeth for gnawing.
   - (*b*) Claws on toes for climbing.
   - (*c*) Tail for keeping feet and body warm during hibernation. *Cf.* dormouse.
4. Rabbit.
   - (*a*) Teeth for gnawing.

(*b*) Claws on toes for scratching.
(*c*) Tail. (*Why, unlike the squirrel's?*) It does not need one for the same purpose. Used as a signal.

5. Elephant.
   (*a*) Nose and upper lip lengthened into a trunk, so as to become equal to a fifth limb.
   (*b*) Teeth enlarged as tusks for defence and attack.

6. Mole.
   (*a*) Teeth sharp for eating small animals.
   (*b*) Feet and fore legs very strong for digging.
   (*c*) Legs short for going through tunnels.
   (*d*) Eyes almost useless, because not needed.
   (*e*) Fur like velvet to suit travelling along narrow passages, so as to hold no earth.

7. Bat.
   (*a*) All limbs used as supports to membrane with which the creature flies.
   (*b*) Hind feet adapted for hanging by.

8. Hedgehog.
   (*a*) Covering, spiny, for protection.
   (*b*) In other respects feeble, because dependent on covering.

BIRDS.

Birds have a special form of covering suitable for flying. It is both warm and light, besides being capable of being spread out. Fore limbs are specially formed as wings.

1. Hen.
   (*a*) Feet for scratching.
   (*b*) Beak for pecking.

2. Duck.
   (*a*) Feet for swimming.
   (*b*) Beak for scooping up out of mud.

3. Owl.
   (*a*) Feet for seizing. *Cf.* cat.
   (*b*) Beak for tearing.
   (*c*) Eyes for seeing in dim light.

4. Heron.

(*a*) Bill for catching fish.
(*b*) Long legs for standing in water.

5. Birds like canary, bullfinch, and sparrow have short strong bills, and feed on seeds or grain.

6. Tails. Birds' tails vary in shape. A broad tail assists flight; heavy birds have special need of such. The long forked tail of the swallow assists the bird to turn rapidly while on the wing. A broad tail would hinder its darting motion.

FISHES, REPTILES, AND FROGS.

All these are cold-blooded, that is to say, the temperature of their blood is a little higher than the water in which many of them live, or the damp places in which others are found.

1. Fish.

(*a*) Scaly covering, a protection against water.
(*b*) Fins for swimming.
(*c*) Gills for breathing water.

2. Snake.

(*a*) No limbs, but body specially powerful in coiling, to make up for deficiency.
(*b*) Poison fangs.

3. Tortoise.

(*a*) Skin and ribs, a hard plate for protection.
(*b*) Limbs weak, because dependent on covering for protection.

4. Frog.

(*a*) Life begun in water, because when young it has no limbs.
(*b*) Gills furnished for the life in water.
(*c*) Lungs grow with legs for life on land.
(*d*) Tongue formed for catching insects.

INSECTS.

1. In larval state protected by—

(*a*) Being hidden in cells, *e.g.*, bee.
(*b*) Colour, *e.g.*, caterpillars.
(*c*) Hairiness, *e.g.*, caterpillars.
(*d*) Living in water, *e.g.*, gnat.

2. In pupa state protected by—
   (*a*) A hard cocoon.
   (*b*) A silky cocoon.
   (*c*) Hiding in the ground.

3. Bee.
   (*a*) Body shaped for entering certain flowers.
   (*b*) Specially formed mouth and throat for carrying and making honey.
   (*c*) Special division into classes, males, females, and workers (or females that lay no eggs).

4. Butterfly.
   (*a*) Beautiful wings.
   (*b*) Specially long trunk to reach into flowers for juices which could not otherwise be reached on account of the large wings.

5. Beetle.
   (*a*) Jaws for eating animal and vegetable food.
   (*b*) Wing cases to protect wings, because the insect generally lives in the ground.

6. Fly.
   (*a*) Feet formed for walking on smooth surfaces.
   (*b*) Eyes large and without lids, because the head cannot be turned.

CRUSTACEANS.

1. Shrimp.
   (*a*) Hard protective covering; jointed for motion.
   (*b*) Tail broad for swimming.
   (*c*) Two legs as pincers for seizing.
   (*d*) Legs used as jaws for eating.

2. Lobster or Crayfish.
   (*a*) As in the case of the shrimp.
   (*b*) Pincers very large and powerful.
   (*c*) A very strong protective carapace.

EARTHWORM.

It has no limbs or sense organs, but is thus suited for life in the earth.

LOWER FORMS.

1. Mollusks.

   (*a*) Soft bodies entirely protected by shell.
   (*b*) Lay numerous eggs to maintain their numbers against numerous foes.

2. Sponges and Corals.

   (*a*) Simple forms unable to protect themselves.
   (*b*) They live in colonies, which build up skeletons that few creatures would eat, and in these they are safe.

LESSON XLVI.

FOSSILS.

This is only intended to be a simple lesson, but such as will tend to develop a lively interest in the existence and teaching of the records of the rocks. It should have a close connection with geography. It is quite probable that the specimens figured below will not be obtainable in many districts, but most districts will yield some specimens, and the lesson will have to be accordingly modified. Drawings of the figures given may well supplement actual specimens. In addition some shells will be required, and, if possible, an example of a so-called petrified substance from a petrifying well.

A COMPARISON.

1. Here is an object (ammonite, Fig. 69) about which we are going to learn something. Observe :—

(*a*) It looks like a shell.
(*b*) It is spirally twisted very much like a snail shell, only the spiral is flattened.
(*c*) It is solid and very heavy.
(*d*) It seems to be made of stone.

2. Other examples, for instance, of bivalve shells should be compared with such shells as were the subject of a previous lesson. Now these heavy stone-like shells are called fossils, and we see :—

(*a*) They are like shells in shape and appearance.
(*b*) But no creatures could live inside them.

WHERE TO FIND FOSSILS.

1. These shells are not the only things that are called fossils; but before explaining what they really are it will be better to know where they are to be found. Some may have been seen in museums, and the fact that they are there shows that a good deal is thought of them. But all of them come out of the earth. There they are generally embedded in hard rock, both near the surface and deep down. Sometimes they are found by splitting open layers of rock; sometimes they have to be carefully chipped out with a hammer; sometimes near the sea they are washed out of the cliffs by the action of the waves, while in some districts very few indeed are to be found.*

2. The word *fossil* means "something dug up," and the things we have been speaking of are so called because they are taken or dug from the rocks of the earth.

3. Quarries and cuttings should be examined, for in such places the rocks are laid bare.

WHAT FOSSILS ARE AND ARE NOT.

1. Here are two fossils (Figs. 70 and 71), the drawings alone will tell what they closely resemble, viz. :—

(*a*) A fish.
(*b*) A crustacean.

2. We see, therefore, that there are fossils resembling shells, fishes, and crustaceans, but all of them are of hard solid stone.

3. Then there is another point to notice. Numerous as are the varieties of shells to be found on land, in lakes, and in the sea, there are none like the ammonite, shown in Fig. 69. There is no fish in the water exactly like that represented in Fig. 70, nor is there any crustacean exactly like that shown in Fig. 71.

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* Chalk and other limestones usually abound in fossils; many sandstones, such as the millstone grit, are almost entirely destitute. Generally speaking, the east and south coasts, the midland and southern counties, are the most favoured parts of the country.

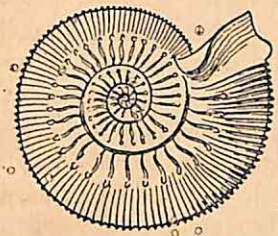

Fig. 69. Fossil Ammonite. Such are found near Whitby, and other places where like rocks occur.

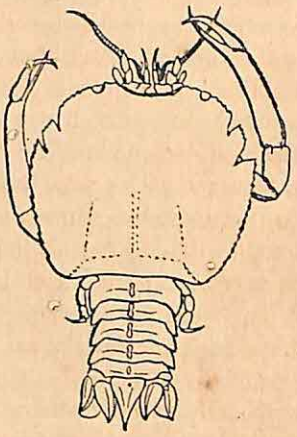

Fig. 71. Fossil Crustacean from the Lias.

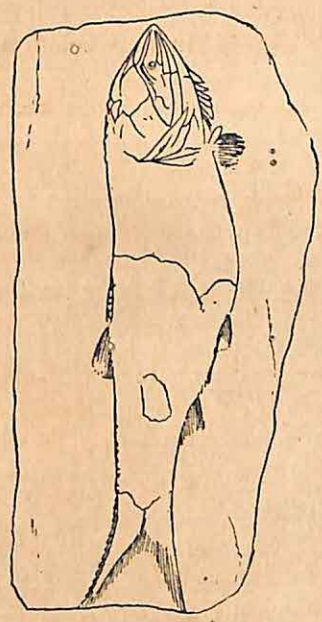

Fig. 70. Fossil Fish (the scales which are clearly seen in the fossil have not been represented) from the New Red Sandstone.

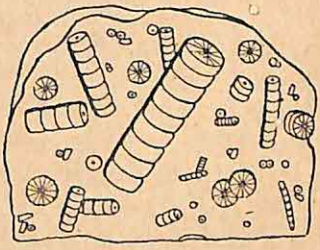

Fig. 72. Fossil portions of Encrinites or Sea Lilies, from the mountain limestone—creatures that were allied to our present star-fishes.

4. Now thousands, nay millions, of such and other kinds of fossils have been found in various parts of the world, some like animals living on land, or in the water, but many unlike them.

5. Children may have seen pieces of wood or other objects that have been coated with lime in a petrifying well, such as are found at Matlock and elsewhere; but these specimens, if broken, show the material inside as it was at first. This is not the case with fossils. They are stony throughout.

6. Notice further that the stone of which they seem to be made is not alike in all cases. If found in limestone they resemble limestone; if found in sandstone, they are sandy in their structure; if found in coal, they seem to be made of coal.

7. Let us then summarize what we have so far learnt :—

(*a*) Fossils are found embedded in the rocks of the earth.

(*b*) They are in the shapes of various animals,—shells, fishes, &c.

(*c*) They are made of solid stone, and not a substance covered with stone.

(*d*) They are made of stone very much like the rock in which they are found.

HOW FOSSILS ARE FORMED.

1. Now let us just consider what must be taking place in the sea at the present time. There are living in it millions of fish, mollusks, crustaceans, and other creatures. Some of these are continually dying and falling to the bottom, so that in some places there will be quite a thick bed of shells. Many of these will turn into lime, but some will keep their shape. These beds get to be hundreds of feet thick. The great pressure of the water and overlying matter will squeeze the whole bed into a solid mass. If in time the bottom of the sea should rise up as it does in some places, this thick bed would dry and be limestone rock full of fossils.

2. Or again many animals, fish, and others, die near the mouths of rivers. What does the river bring down? Mud and sand. What will happen to those creatures dying in such places? They will be buried in the mud or sand.

3. If an animal dies and is buried in the earth, it gradually wastes away, turning into gas, and the gas passes into the light earth; but when animals are buried in the mud or sand at a river mouth, the pressure of the overlying sand and water is so great that it cannot waste in this way, but as it changes bit by bit, some of the surrounding matter joins with it and makes a new but similar substance, which keeps the shape of the former piece. Thus, or in such a way, fossils are formed.

WHAT FOSSILS TELL US.

1. We conclude that all fossils were formed in such a way as is described above, that fossils are animals turned to stone, and so we know :—

(*a*) Rocks have been formed in water as others are being formed now.

(*b*) What is now dry land has been under water.

(*c*) The fossils tell us what animals lived at that time.

2. Comparing fossils with existing animals, we see :—

(*a*) Many animals that lived in those times have become extinct, but similar ones are now living, and

(*b*) (it may be added) many now living are not found as fossils.

3. To conclude, here is a drawing of a piece of limestone, Fig. 72, made up entirely of fossils. This limestone is often polished and used for mantelpieces. The fossils are called sea-lilies, when alive they must have been animals on stalks resembling the sea-anemone, coral, or sponge.

Note.—1. In suitable localities this lesson would greatly gain in value by a conducted visit to a quarry or cliff or cutting, or in a town to a museum. The children may be encouraged to collect fossils, but in doing so they should note the exact place where each fossil is found, and the kind of rock in which it was embedded.

2. The collecting of shells and fossils is more educational than that of stamps, and free from the temptation to cruelty involved in collecting eggs and insects.

APPENDIX.

NOTE ON CORRELATION OF STUDIES WITH OBJECT LESSONS.

UNDER conditions of teaching which are, happily, now passing away, but have not yet entirely disappeared, it has seldom been found possible to arrange courses of lessons in such a manner as to secure the greatest economy in teaching power. As economy in dealing with money means "wise spending," so economy in teaching power implies an output of effort that results in the best and fullest return in the form of well-developed activities on the part of the pupils.

Every new acquisition of knowledge or activity increases the capacity for further acquisition; and this being so, it becomes of the utmost importance that studies should be so arranged as to be presented in that order in which acquisition or assimilation takes place most easily. Such a course is a gain to both teacher and pupil—to the former in ease, to the latter in interest; and these two mutually re-act.

The principle on which this statement is based was first expounded by Herbart in the early days of the present century, and by him called the doctrine of APPERCEPTION. Briefly stated, it means that perceptions are received into the mind and become part of the mental store, only with an ease proportioned to the closeness of their inherent relationship to the whole or part of the general MASS OF IDEAS previously established in the mind. Lessons, then, should so follow, and be of such a character, as to give rise to ideas most readily apperceived.

It is not always recognized that this end is approached by framing courses of object lessons having a natural connection or sequence. Yet there can be no doubt that if a perfect sequence could be obtained, there would be no need for repeating every lesson once or twice as is often done. For instance, a lesson on a frog should follow, not precede, one on a fish; otherwise it becomes difficult to explain the characters of tadpoles; and, further, these lessons should be taken in March or April, when eggs and tadpoles can be found in every pond. Should such a lesson as that on the Frog be considered to need repetition, the end desired is better gained by taking a lesson on the Common Newt, when the same characteristics are

presented, but in association with another creature, so that recapitulation, added interest, and extended knowledge are the result.

Two kinds of correlation are here suggested, that of sequence, and that of the subjects to the seasons. It is a great gain to make lessons fall, as it were, in their due season. The Fish, Frog, Newt, Buds, Rootstocks (underground stems), Bulbs, Unfolding of Leaves, Germination, Flowers of Forest Trees, Apple Blossom, Birds' Nests, Eggs, &c., make excellent EARLY SPRING LESSONS, while AUTUMN LESSONS would comprise such subjects as the various aspects of Harvest, Grain and its Products, Fruits, Migration of Birds, Autumn Tints, Falling of Leaves, &c.; and those of WINTER, Oranges, Raisins, and Other Foreign Fruits, Robin, Sparrow, Snow, Ice, Wearing Away of Land, Hibernation, &c.

In many subjects taken from the vegetable kingdom, where different seasons present different aspects, as in the biennials (turnip, cabbage, &c.), and fruits like the apple and acorn, the best seasonal correlation is obtained by dividing the subject, and taking each part in its own season. In this way the Potato provides three lessons—the Tuber alone in winter; the Sprouting and Early Growth in spring; and the Flowers, Fruit, and New Tubers in summer.

But besides this seasonal correlation, and that of sequence, there is the correlation of studies, or that of the subjects in a series to those in other series. That the subject of an object lesson being made the theme of a composition is a gain to both lessons needs no demonstration. Still greater, then, must be the advantage if the same object can be made to provide a copy for the drawing lesson, and the reading book to furnish a reading relative to it.

Where some form of handwork is taught, still further correlation is possible, and no subjects lend themselves so readily, and at the same time so fully satisfy the highest educational demands, as clay modelling and water-colour brush work. Many fruits and vegetables supply excellent models for clay; while leaves, simple and compound, their shapes,* position on stem, simple plant forms, and conventional forms derived from them, flower forms like the snowdrop, willow-herb, &c., insect forms, &c., are admirable copies direct from nature for the brush. Besides the value of these forms for the direct purpose of developing manual expression, there is at the same time no means so easy and pleasant of acquiring a knowledge of the shapes of leaves and other features of plant and animal life.

Beetles, butterflies, bees, and other insects, lizards, newts, frogs, &c., make good brush copies, and, if sketched in simple outline, equally good freehand drawing copies. For the latter purpose, may be mentioned:—

* See "Object Lessons from Forest, Field, Wayside, and Garden," Book II.

Cat	Duck	Butterfly	Scallop
Tiger's head	Owl	Moth	Trochus
Elephant	Various fishes	Beetle	Sponge
Cow's horns	Frog	Bee	&c.
Camel	Newt	Snail shell	
Bat	Lizard	Oyster	

(For leaf forms see Botany Book.)

Many animal forms may be developed from the ellipse, which should be drawn with a single sweep. Some examples of this kind will be found in the alternative scheme of drawing issued by the Science and Art Department—a scheme which is capable of much closer correlation than the one usually adopted, but which, in any case, offers many suggestions.

For clay work, the botany lessons provide the best models, but some animal forms are useful :—

Orange	Carrot	Brazil nut	Fish (minnow)
,, section	Radish	Peach (section)	Tortoise
Apple	Potato	Duck's foot	Horse's foot
,, section	Onion	Frog's foot	Cow's foot
Pear	Acorn	Duck's head	&c., &c.
Turnip	Walnut	Mouse	

Geography lessons are drawn into the net, and even arithmetic. The extent, however, to which the correlation of the latter can be carried out is, perhaps, somewhat limited, but not so much so as might at first appear. It could hardly be called carrying method too far to propose such sums as the following :—Seventeen frogs in a pond laid 26 eggs each, find the total number laid ; if three out of every eight are destroyed, what number of tadpoles may be expected to appear ? If finally there are 128 frogs, how many tadpoles have died or been eaten ? and what is the total waste out of the 442 eggs ? &c., &c.

Such sums provide exercises full of interest, and at the same time recapitulate the leading facts in the development of the frog. Again, take a flower-spike of foxglove, and propose to ascertain the number of seeds borne by one plant. A single capsule by the process of *halving* is cut into *eighths*, the number of seeds in one-eighth counted, and the total estimated.

More suggestions might be made, but enough has been said to indicate some of the possibilities of the method, and it is surprising how numerous and far-reaching are the correlations that can be made when once such a course has been entered upon.

Compositions leading to word-building lessons in the lower standards may be based on the object lessons, and much more interest in this subject is induced when the need for the spelling of the word is felt, than in

a piece of dry dictation. Even the built-up compositions of the children and teacher may afterwards be dictated.

All these studies, then, centre round and constitute what Herbart calls the scientific *core*, all others naturally falling into another group, the content of which is primarily ethical, with which this note is not intended to deal.

It may be well to observe in passing that correlating studies does not mean allowing one subject to displace or interfere with another, as the turning of a reading lesson into a grammar or spelling lesson, a course which all educationists would rightly deprecate.

Finally, if isolated lessons may be likened to scattered links, lessons connected by sequence in a series, such as those in this book, may be compared to a chain, but correlated studies are a number of chains united at all points into a coat of mail.

It has been well suggested that the purposes of a close correlation are:

1. To prevent duplication.
2. To eliminate non-essentials.
3. To save time and effort.
4. To develop the apperceiving power of the mind.
5. To develop character. This last refers to the purely ethical purpose which, as has already been stated, has not come within the purview of this note.

One or two points are here worthy of mention by way of rule:—

1. Thought should always precede expression.
2. Expression is both verbal and manual.
3. Children cannot see far-reaching or unifying principles.*

A few correlated lessons may not be out of place as an indication of what may easily be attempted in an elementary school.

I.	
Object Lesson.	The cat (general).
Language.	Story of a cat.
	Children tell story.
Drawing.	Outline of cat.
Arithmetic.	Based on facts connected with cat.
Spelling.	Words arising out of story.
Object Lesson.	Cat (details).

II.	
Object Lesson.	The horse.
Language.	A story.
	Composition on the same.
	Spelling lesson.
Modelling.	Horse's foot.
Object Lesson.	A horse shoe.
Language.	Story of ditto.
	Composition, &c., &c.

* For a full statement of the principles on which much of this Appendix is based, see "Herbart and the Herbartians" (De Garmo, Heinemann), a book to which I acknowledge my indebtedness with gratitude.

III.	
Geography.	A river.
Object Lesson.	Riverside trees, alder, willow.
Language.	Story of walk.
Object Lesson.	Fish from river.
Drawing.	A fish.
Language.	Composition. Spelling.
Arithmetic.	Based on the above.
Object Lesson.	The frog.
Geography.	Ponds and lakes, &c., &c.

IV.	
Object Lesson.	Butterfly.
Handwork.	Brush drawing of butterfly.
Language.	Mrs. Gatty's parable. Composition. Spelling. Dictation.
Drawing.	Butterfly.
Object Lesson.	Caterpillar, &c., &c.

The lessons contained in this book possess only the correlation of natural sequence in a single series, for in a book of this kind no more could be attempted. The drawings have been done in outline in the hope that they will be of service as drawing copies and be easily reproduced on the black-board.

The lessons in the contents marked with an asterisk may be taken as pure *object* lessons, the others will generally lie outside that range.

The market is well supplied with diagrams showing single animals, but these should never be made to do duty for the real object. Messrs. Jarrold publish an excellent set of sheets, well drawn and very cheap, on which all the mammals are shown in properly classified groups. These will be found exceedingly useful in summarizing and comparing. They are entitled, "JARROLDS' ILLUSTRATIONS OF THE ANIMAL KINGDOM," and consist of 12 sheets, which are sold together or separately.

I must acknowledge my indebtedness to "Warne's Royal Natural History," which I strongly recommend.

For those who wish to establish an aquarium, Taylor's book is the best I am acquainted with. The secret of management of an aquarium is that the balance of animal and plant life should be maintained as in a good pond.

Jarrold & Sons, Printers, Norwich, Yarmouth, and London.

JARROLDS' COLOURED ILLUSTRATIONS

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